# KODAIKÁNAL AND MADRAS OBSERVATORIES.

## REPORT FOR THE YEAR 1905.

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# KODAIKÁNAL AND MADRAS OBSERVATORIES.

## I.—REPORT OF THE KODAIKÁNAL OBSERVATORY FOR THE YEAR 1905.

1. **Staff.**—The staff of the Observatory on the 31st December 1905 was as follows:

| | |
|---|---|
| Director | C. Michie Smith, B.Sc. |
| Assistant Director | *Vacant.* |
| First Assistant | K. V. Sivarama Aiyar, M.A. |
| Second Assistant | S. Sitarama Aiyar, B.A. |
| Third Assistant | G. Nagaraja Aiyar. |
| Fourth Assistant | S. Balasundaram Aiyar. |
| Writer | L. N. Krishnaswamy Aiyar. |
| Photographic Assistant | R. Krishna Aiyar. |

The First Assistant was absent on furlough and extraordinary leave from the beginning of the year till May 29. The Second Assistant was absent on privilege leave from August 15 to September 23. The Third Assistant was absent on privilege leave from September 24 to December 23. Mr. M. G. Subrahmanya Aiyar of the Madras Observatory staff, who was acting as Third Assistant during the absence of the First Assistant on furlough, was transferred to the Survey of India Department on May 6 as Magnetic Observer here. Mr. S. S. Ramaswami Aiyangar acted for three months as an extra Assistant, and subsequently acted as Fourth Assistant during the absence of the Second and Third Assistants. Towards the end of the year Government, at the request of the Director, sanctioned the addition to the staff of a permanent Photographic Assistant.

The subordinate staff of the Observatory consists of a book-binder and book-binder's boy, a mechanic, four peons and a boy peon for the dark room, and two lascars.

2. **Distribution of work.**—The Director takes charge of the spectroheliograph and is helped by the Photographic Assistant. The First, Second, and Third Assistants are also trained to use the instrument if necessary. The First, Second and Third Assistants are in charge of the work with the Cooke equatorial (spectroscopic), the Lerebour and Secretan equatorial (visual), the photoheliograph, the transit instrument, and the seismometer. They have also to do the astronomical computing and the preparation of the observations for the press. The Fourth Assistant has charge of the clock comparisons and, with the help of the writer, is responsible for the whole of the meteorological work. The writer is responsible for the accounts, correspondence, and all office records.

3. **Buildings and grounds**—(*a*) *Spectroheliograph building.*—This building has continued to give much trouble In the main building venetian shutters have been placed in six of the windows with most beneficial results, but the roof continues to leak in several places. There is no particular difficulty in curing this as a suitable material has been found for the purpose but for some unexplained reason, and in spite of frequent reminders, only a small part of the work has been done. The sliding roof which covers the siderostat was nearly blown off the rails several times during the south-west monsoon, and had to be temporarily strengthened internally by wooden struts. A design for a new and much smaller roof has been submitted and sanction for this is now awaited.

(*b*) *Photoheliograph house.*—It was mentioned in last year's report that plans for a new building for the photoheliograph had been prepared. These were sanctioned and the walls of the building have been completed except for the cut stone ring which carries the rails. The dome has not yet arrived from the makers. The building consists of a 15-foot dome with a small dark room on the south side and a porch to protect the door on the north.

(*c*) *Workshop*—The new workshop has been finished and brought into use. The old workshop is now occupied by the book-binder and the old book-binder's shed is used as a store room. These changes add greatly to the convenience of the establishment.

(*d*) *The Fourth Assistant's quarters* were completed and occupied, but they still want a fence to keep off straying cattle.

(*e*) *House for the Assistant Director.*—Plans and estimates for this were prepared and after much delay have been forwarded to the Government of India for sanction. Work has not yet been begun on the building.

(*f*) The usual repairs have been carried out and the buildings, with the exception of the spectroheliograph house referred to above, are all in good order.

(*g*) *Grounds.*—The roads and paths have been kept in good order, and a number of trees and shrubs have been planted. Much more requires to be done in this direction, but the season was not a favourable one for planting out young trees. A number of seedlings have, however, been raised and if the weather is favourable will be planted out in the coming spring. In January some damage was done to the young trees in part of the compound by a forest fire which swept round nearly half a mile of the boundary of the Observatory grounds. Fortunately the Observatory fire lines were in good order and the long grass had been removed from the chief plantation so that it was found possible to stop the fire soon after it crossed the boundary. Some fifty blue gums were badly burned and had to be coppiced, and a number of young trees were scorched by the heat as much as 50 yards from the point actually reached by the fire. A few of these have died, but most of them have recovered.

(*h*) The well from which the aermotor pumps was dry for about three months, but a new well had been opened which fortunately proved permanent and yielded an ample supply of water. All the water, however, had to be carried from this well for a distance of a quarter of a mile with a rise of over 100 feet. During the rest of the year the aermotor and pumps gave satisfaction.

4. **Instruments.**—The following are the principal instruments belonging to the Observatory :—

- Six-inch Cooke equatorial.
- Six-inch Lerebour and Secretan equatorial, remounted by Grubb with a 5-inch Grubb portrait lens of 36-inches focus attached.
- Spectrograph—consisting of an 11-inch polar siderostat, 6-inch Grubb lens of 40-feet focus, and a 4-inch concave grating of 10-feet focus, mounted on Rowland's plan. A plane grating with collimator and camera lenses of 8-feet focus can be substituted for the concave grating.
- A rhomb with ends cut at 45°, mounted on a graduated circle, can be placed in front of the slit so as to enable any part of the limb to be brought on to the slit.
- Six-inch transit instrument and barrel chronograph, formerly the property of the Great Trigonometrical Survey of India.
- Six-prism table spectroscope—Hilger.
- Photoheliograph Dallmeyer No. 4.
- Theodolite, six-inch—Cooke.
- Two phototheodolites by Steinheil for cloud photography.
- Sextant.
- Spectroheliograph with 18-inch siderostat and 12-inch Cooke triple achromatic lens of 20-feet focus, by the Cambridge Scientific Instrument Company, Limited.
- Evershed spectroscope with three prisms for prominence and sunspot work, by Hilger.
- Mean time clock, Kullberg 6326.
- Sidereal clock, Shelton.
- Mean time chronometer, Kullberg 6299.
- Sidereal chronometer, Kullberg 6134.
- Tape chronograph, Fuess.
- Micrometer for measuring spectrum photographs, Hilger
- Dividing engine, Cambridge Scientific Instrument Company, Limited.
- Two Balfour Stewart actinometers.
- Buchanan's solar calorimeter.
- Induction coil with necessary adjuncts.
- Small polar siderostat.
- Universal instrument.
- Complete set of meteorological instruments, including Richard barograph and thermograph, and wind-recorders.

A high class screw cutting turning lathe by Messrs. Cooke & Sons was received at the end of the year.

*The Spectroheliograph.*—The spectroheliograph has been in constant use throughout the year and has given satisfaction except as regards the slits. These are of a complicated structure and have proved far from satisfactory. A grain of dust—and dust is sadly too abundant here at certain seasons—throws them out, and it is exceedingly difficult to keep both jaws in the same plane. Various plans have been tried to make them work better with fair success so far as the camera slit is concerned. The collimating slit has been more difficult to correct and a new slit of a simpler design has been asked for. The negative lens for enlarging the image formed by the 12-inch lens was received on May 9 and was at once set up, but has not been much used. It is not often that the sun's image is sufficiently steady to make it possible to get a really satisfactory enlarged image, and it is only when there is some special feature to photograph that the attempt is made. The want of steadiness in the image of the sun is due to several causes. The most prominent is, doubtless, the unsatisfactory position of the building. Why the present site was chosen is not known as two much better sites were available, but as it is too late to make a change now various attempts have been made to improve the surroundings. Unfortunately the ground surrounding the building is very rocky and it is difficult, if not impossible, to cover it with vegetation. An attempt is being made to cover it as far as possible but this will take time. Inside the large siderostat building blankets and mats have been placed on the floor and a wind screen has been placed near the mirror. These have done some good. Inside the main building the placing of venetian shutters in the windows had a good effect but it was not sufficient. A tube consisting of a wooden frame covered with very loosely woven cloth has been placed between the lens and the photoheliograph and this has made a most marked improvement. When the new building for the siderostat is erected the mirror will be brought much closer to the lens and it is hoped that this will improve matters still further.

It is not always easy to distinguish between unsteadiness due to purely local conditions and that due to the state of the higher atmosphere, but the contrast between the conditions at the spectroheliograph and at the spectroscope in the dome on the top of the hill is often so marked that there can be no doubt that the trouble at the former is often purely local. Some of the trouble here, as elsewhere, is probably due to deformation of the mirror by heat. This has been reduced to a minimum by keeping a lamp burning under the mirror case all night and by adopting Professor Hale's suggestion of removing the mirror cover only when a photograph is being taken. Changes in focus are usually small.

The inner surface of the back lens of the 12-inch having become badly covered with fungus the lenses were taken apart and successfully cleaned during the visit of the Director-General in December.

All the other instruments belonging to the observatory are in good order and working well.

## OBSERVATIONS.

### (*a*) Solar Physics.

5. The year was, on the whole, a favourable one for solar observations, and there were only nineteen days on which no observations were possible. At the same time it should be noted that, especially in the latter part of the year, observations of prominences were to a larger extent than usual interfered with by cirrus clouds. Satisfactory statistics on the subject are not available, but the impression left on the observers is that trouble from this source, in otherwise fine weather, has been distinctly greater than in former years. On the other hand the increased skill of the observers has made it possible to record the prominences on days when the conditions were far from satisfactory. The following table shows for each day the observations that were made.

# Solar Observations in 1905.

A=Spots observed. B=Spot spectra. C=Prominences. D=Photoheliograms. E=Spectroheliograms.

| Date. | January. | February. | March. | April | May. | June | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 .. | A —— | A B C D E | A B C D E | A — D E | A — C D E | A — *C* D E | A B C D E | A — C D E | A — D E | A B C D E | A B C D E | A B C D *E* |
| 2 .. | —— | A B C D E | A B C D E | A — C D E | A — C D E | A B C D E | A — C D E | A —— *E* | —— | A B C D E | A — *C* D E | A — C D — |
| 3 .. | A —— | A B C D E | A B C D E | A — D — | A B C D E | A B C D E | A — C D E | A — *C* D *E* | A B C D E | A B *C* D *E* | A B *C* D *E* | A — *C* D *E* |
| 4 .. | A B C D E | A B C D E | A — D E | A — C D *E* | A B C D E | A — *C* D *E* | A B C D E | A B C D E | A — C D E | A B — D *E* | A — C D E | A B C D E |
| 5 .. | A — C D E | A B C D — | A B C D E | A — *C* D *E* | A B C D E | A B C D E | A B C D E | A B C D E | A — D E | A — D — | A B C D E | A B C D E |
| 6 .. | A — *C* — | A B C D E | A B C D E | A B C D E | A B C D E | A B C D E | A B C D E | A B C D E | A — D — | — | A B C D E | A — C D E |
| 7 .. | A — C D E | A B C D E | A B C D E | A — C D E | A B C D E | A B C D E | A B C D E | A B C D E | A — D — | — | A B C D E | A B C D E |
| 8 .. | A — *C* D E | A B C D E | A B C D E | A B C D E | A — *C* D E | A B — *E* | A B C D E | A B C D E | A — D — | — | A — D — | A B C D *E* |
| 9 .. | A B C D E | A B C D E | A B C D E | A — C D E | A B C D E | A B — E | A — C D E | A B C D E | A — D *E* | A B C D E | A B *C* D E | A — C D E |
| 10 .. | A B C D E | A B C D E | A B C D E | A — D — | A B C D E | — | A —— *E* | A — *C* D E | A — *C* D E | A — *C* D E | A — D *E* | A *B* C D E |
| 11 .. | A B C D E | A B C D E | A — C D E | A — C D E | A B C D E | A B C D E | — | A B C D E | A — C D E | A — *C* D E | A B C D E | A B C D E |
| 12 .. | A B C D E | A B C D E | A — C D E | A — *C* D E | — | A B C D E | A B C D E | A B C D E | A — D *E* | — | A — D E | A — *C* D *E* |
| 13 .. | A B C D E | A B C D E | A — C D E | A B C D E | A — D *E* | A B C D E | A — C D E | A — C D E | — | A — *C* D — | A —— | A — *C* D *E* |
| 14 .. | A B C D E | A B C D E | A — C D E | A B C D E | A — C D E | A — C D *E* | A B C D E | A —— | A — *C* D E | A — D — | A — D — | A B C D E |
| 15 .. | A B C D E | A — C D E | A — C D E | A B C D E | A B *C* D E | A B C D E | A B C D E | A B C D E | A — *C* D E | A —— | A — D — | A B C D *E* |
| 16 .. | A B C D E | A B *C* D E | A — C D E | A *B* C D E | A B C D E | A B C D E | A *B* C D E | A — *C* D E | A — *C* D E | A B C D E | A B C D E | A B C D *E* |
| 17 .. | A B C D E | A — *C* D E | A — C D E | A —— | A B C D E | A — C D E | A B C D E | A B C D E | A — C D E | A — *C* D E | A B C D E | A B C D *E* |
| 18 .. | A B C D E | A B C D E | A — C D E | — | A — C D E | A —— | A — D — | A — D — | A — D — | A B *C* D E | A B C D E | A B C D E |
| 19 .. | A B C D E | A — C D E | A — C D E | A B C D E | A B C D E | — | A — — | A — D E | A — C D E | A — *C* D — | — | A B C D E |
| 20 .. | A B C D E | A — C D E | A — C D E | A B C D E | — | A —— | A — D *E* | A B C D E | A — C D E | A B C D E | A —— | A — *C* D E |
| 21 .. | A B C D E | A — C D E | A — *C* D E | A B C D E | A —— *E* | A — *C* — | A — D *E* | A B C D E | A — C D *E* | A B C D E | A — *C* D *E* | A B C D E |
| 22 .. | A B C D E | A — C D E | A — *C* D E | A — C D *E* | A — C D E | A — C D E | A —— | A — D *E* | A — C D E | A B C D E | — | A B C D E |
| 23 .. | A B *C* D E | A — D E | A B C D E | A B C D E | A — C D E | A B C D E | A — *C* D *E* | A — D *E* | A — C D *E* | A B C D E | — | A B C D E |
| 24 .. | A — C D E | A B C D E | A — C D E | A B C D E | A — C D E | A B C D E | A B C D E | A — D *E* | A — *C* D *E* | A B C D E | — | A B C D *E* |
| 25 .. | A — C D E | A B C D E | A — C D E | A — C D E | A — C D E | A — *C* — *E* | A — C D E | A — C D E | A — *C* D E | A B C D E | A — D — | A B C D *E* |
| 26 .. | A — C D E | A B C D E | A B C D E | A — C D E | A — C D E | — | A — C D E | A — *C* D E | A — C D E | A B C D E | A — *C* D *E* | A *B* C D *E* |
| 27 . | A — C D E | A B C D E | A B C D E | A — C D E | A — C D E | — | A — *C* D E | A B C D E | A — C D E | A B C D E | A — C D *E* | A B C D E |
| 28 .. | A — C D E | A B C D E | A — D E | A — C D E | A — C D *E* | A B C D E | A — C D E | A B C D E | A — C D E | A B C D E | A B C D *E* | A B C D E |
| 29 .. | A B C D E | | A B C D E | A — C D E | A — C D E | A B C D E | A — C D E | A — C D E | A B C D E | A B C D E | A B C D *E* | A — D *E* |
| 30 .. | A B C D E | | A — C D E | A — C D E | A — C D E | A — C D E | A — C D *E* | A B C D E | A B C D E | A B C D E | A B C D *E* | A B C D E |
| 31 .. | A B C D E | | A — *C* D E | | A — C D E | | A — *C* D E | A B C D E | | A B C D E | | A B C D E |

*Note.*—Where a letter is in italics it means that on that the day observations were not complete.

Solar observations—abstract.

| | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 30 | 28 | 31 | 29 | 29 | 26 | 30 | 31 | 28 | 27 | 26 | 31 | 346 |
| B | 19 | 21 | 13 | 12 | 12 | 16 | 12 | 16 | 3 | 19 | 13 | 23 | 179 |
| C | 28 | 27 | 29 | 25 | 27 | 22 | 24 | 24 | 20 | 23 | 18 | 30 | 297 |
| D | 27 | 28 | 31 | 28 | 28 | 20 | 27 | 29 | 28 | 26 | 24 | 31 | 327 |
| E | 27 | 28 | 31 | 26 | 29 | 23 | 27 | 29 | 24 | 22 | 21 | 30 | 317 |

6. **Photographs of the sun** with the Dallmeyer photoheliograph were taken on 327 days as against 264 in 1904. June was the least favourable month for this work as there were 10 days on which no photograph could be obtained. In February, March, and December there was no day on which a photograph could not be obtained. As a rule only one photograph is taken daily. Negatives for 45 days have been sent to the Astronomer Royal at his request.

7. **Observations of sunspots.**—The sun is examined for spots and faculae every morning when the weather permits. When possible, the sun's image is projected on an 8 inch disc, and the positions of the spots and faculae are marked on it. Eye observations are also made of important features. There were only 19 days on which no observations of this class could be made, but on a good many other days the observations were made with difficulty through breaks in clouds.

8. **Sunspot spectra.**—Observations of widened lines in sunspot spectra were made with the Evershed three-prism spectroscope on 179 days. Observations of widened lines are made only when the spots are large enough to render the results satisfactory, but on all other days, when the weather permits, the neighbourhood of spots is carefully studied as regards the behaviour of the hydrogen and helium lines. The study of the helium line $D_3$ has proved particularly interesting.

9. **Prominences.**—Prominences were recorded visually on 297 days, but on 47 of these the observations were either not complete or not satisfactory on account of the weather. On some other days, though the whole limb was swept for prominences, the work had to be done hurriedly through breaks in the clouds, and small prominences may have been overlooked. The record of the prominences is made round the disc on which the spots and faculae have been projected. This record is compared next day with the photographs taken with the spectroheliograph and all prominences shown in the photograph but not in the drawing are added in blue pencil. Where there is much difference between the photograph and the drawing the differences are noted on the disc. On a number of days the photographs have rendered it possible to complete the eye record which had been interrupted by clouds. Usually, however, a day on which it is impossible to get eye observations of prominences is one on which good spectroheliograms are also impossible. It has not been possible to devote much time to prominence spectra, and only the most conspicuous bright lines are recorded.

10. **Spectroheliograms.**—Photographs were obtained with the spectroheliograph on 317 days, but on 47 of these the results were not satisfactory. These failures were due mainly to unsatisfactory weather conditions, but a few of them were due to slit troubles. When the weather is cloudy it is often found to be almost impossible to set the second slit on the H line with sufficient accuracy, and the construction of the slits is such as to render it impossible to use Professor Hale's old device of having a small window through which setting can be made on another and more easily seen line. The present setting arrangement is not quite satisfactory and a modified form of apparatus has been asked for.

As mentioned above, much trouble has been caused by the want of steadiness in the sun's image, and the best results are usually obtained early in the forenoon. On some occasions excellent photographs of flocculi have been got through comparatively

thick clouds but, naturally, it is rarely possible to obtain good prominence pictures except with a clear sky. The plan of taking composite pictures of the flocculi and prominences on the same plate with two exposures has been given up as it is found much more satisfactory to take the two on separate plates. If the instrument was fed by means of a cœlostat, there might be some advantage in the composite pictures, but when a siderostat is employed, as is the case here, the rotation of the image between the two exposures causes an objectionable displacement of the one image relatively to the other. On the whole, including plates taken for focussing and other adjustments, 1,177 photographs were taken with the instrument, of which 215 have been rejected for various reasons. An enlarged copy of the best flocculi plate for each day is made on bromide paper, and these are found very useful for reference. Of course, any serious studies must be made on the negatives themselves, but the copies are useful for selecting suitable negatives and as a convenient index to the series. The general results obtained with the instrument may be described as satisfactory, but the plates are not yet so uniformly good as is to be hoped they will soon be. The various changes which have been made in and about the buildings have undoubtedly done good, and the farther changes which are projected should improve the conditions still farther, while the small instrumental changes which are proposed would greatly simplify the use of the instrument.

*Summary of Results.*

11. **Sunspots.**—The following table shows the monthly number of new groups observed, the mean daily number of spots visible, and the distribution as regards the northern and southern hemispheres :—

| — | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups .. .. .. | 24 | 26 | 20 | 27 | 27 | 17 | 32 | 28 | 27 | 16 | 29 | 22 | 295 |
| Daily number .. .. | 5·8 | 6·1 | 3·6 | 3·7 | 4·3 | 3·6 | 5·0 | 5·1 | 4·9 | 3·3 | 6·7 | 4·0 | 4·7 |
| North .. .. .. | 13 | 11 | 10 | 14 | 20 | 8 | 17 | 22 | 17 | 11 | 13 | 13 | 169 |
| South .. .. .. | 11 | 15 | 10 | 13 | 7 | 9 | 15 | 6 | 10 | 5 | 16 | 9 | 126 |

The total number of new groups seen during the year was 295 against 239 in 1904. There were two days, July 28 and 29, when the visible disc was free from spots, and there were 13 days on which only one group was visible. The greatest number of groups seen on any day was 15 on January 14. Ten or more groups were seen also on January 14 and 16 and on February 9 to 14.

The distribution of the groups between the two hemispheres was again very far from uniform, there being 33 per cent. more groups seen in the northern than in the southern hemisphere. In the two months May and August there were 42 northern to only 13 southern groups. The mean latitude of the spots was less than in 1904, and in September there was a group within 1° of the equator. The most important groups seen during the year were the following :—

Nos. 449, 450, 451 came round the east limb as detached spots on the 10th and 11th January but in two or three days they formed into a continuous train covering 16° of longitude.

No. {443, 464, 488, 507} was the largest spot that had been seen for many years. It was seen during four rotations. It was a disturbed spot and was associated with very disturbed prominences at both limbs. It formed on the visible disc on January 5 and was last seen on April 5.

No. {465, 491} was seen first from February 2 to February 14. It returned to view as a very large spot on March 1, but soon began tc grow smaller, and by the time it reached the western limb it was reduced to a small dot in a large field of faculae.

No. 547 appeared at the east limb on May 11. It was preceded by intensely bright prominences which were seen for two days. At its maximum it covered 18° of longitude.

Nos. 589, 590, 613, 637, 656. When spots Nos. 589 and 590 came round the limb on July 6, they appeared to form two separate groups but these rapidly increased in size and joined together forming one large group consisting of two main clusters joined by a number of small spots. It remained visible during four rotations.

Nos. 594, 620 came round the east limb on July 10 and was the largest since the great spot of February. On the 16th the group was at least 120,000 miles long with a maximum width of about 44,000 miles. It was seen during two rotations.

No. 674, which appeared at the east limb on October 14 consisted of a large number of small spots covering about 130,000 miles in length and 65,000 miles in breadth.

No. 676, which appeared on October 22 was also a very large spot group but of a totally different type from 674 as it consisted mainly of one large spot. Both 674 and 676 were easily seen without a telescope.

No. 708, consisted of a very long train of large spots and was first seen on November 25. It broke up into several groups which extended over some 28° of longitude.

12. **Prominences.**—As the prominence observations are being published in full in the Bulletins of the observatory it is not necessary to give a complete list here, but a few notes are given on some of the more important prominences of the year.

*January.*—Prominences were very abundant during this month. The highest noted was on the 22nd in latitude + 42° (east). It was 3′ high. There were four prominences seen of about 2′ and 13 of about $1\frac{1}{2}'$ high. On the 27th there was a group of small prominences covering about 20° of the limb, on three days there were groups covering 15°, and on eight other days groups covering 10°.

*February.*—The tallest prominence that has been observed here was photographed on the 20th in the calcium line H, at position angle 45°. When the first photograph was taken at $8^h\ 36^m$ it had a height of 95,000 miles, another photograph at $9^h\ 18^m$ showed that it had risen to 108,000 miles, while in a photograph taken at $10^h\ 14^m$ its height exceeded 162,000 miles, and it had got beyond the limits covered by the spectroheliogram. On the 25th, 26th, and 27th nearly 28° of the eastern limb was covered with bright prominences.

*March.*—On the 1st, where spot No. 491 was coming round the limb, there was a large and rapidly changing prominence which reached a height of about 3′, and the next day, near the same place, an eruptive jet was observed to reach a height of nearly 4′. Even on the following day a prominence nearly 2′ high was seen at the limb near the same place. Prominences more than 2′ high were observed on the 8th, 11th, 13th, and 30th. On the 15th a long series of prominences extended from position angle 230° to 287° and on the 23rd nearly 70° of the eastern limb was covered with prominences.

*April.*—The tallest prominence seen was one of 2′ on the 15th at position angle 59°. On the 14th about 40° of the limb was covered with short bright prominences none of which exceeded 45″ in height. On the 24th two great arches, each covering 8° of the limb and joined in the middle, were photographed in calcium light. These reached heights of 65″ and 70″ respectively.

*May.*—A large number of conspicuous prominences were observed during this month. There were 50 of or over 1′ in height of which 7 were above 2′. The most striking display was on the 1st near the south point of the sun. At $8^h\ 28^m$ it was about $2\frac{1}{2}'$ high and at $10^h\ 31^m$ it reached a height of at least $4\frac{1}{2}'$. On the same day a large cloud was seen at position angle 10° which at one time was apparently quite detached from limb and about $2\frac{1}{2}'$ above it. On the 2nd nearly 50° of the west limb was covered with short prominences.

*June.*—There were 27 prominences seen of or over 1′ in height, of which one exceeded 3 minutes and two others exceeded 2 minutes. The tallest of these was seen and photographed about 9 o'clock on the morning of the 22nd. It rose from the sun's limb at position angle 58° and drifted northwards like the smoke from a steamer till it could be traced to a height of 195 seconds over a point on the limb 20° north of where it was issuing. The form changed very rapidly.

*July.*—There were no very conspicuous prominences seen during the month. Some 20 exceeded one minute in height and of these only two exceeded 100 seconds.

*August.*—Prominences exceeding 1′ in height numbered 44, and on 12 days prominences covering 15° or more of the limb were observed. The tallest prominence seen was one $3\frac{1}{2}'$ high which was photographed on the 15th. The gas apparently issued at position angle 100° in a nearly vertical jet which reached a height of 90″; it then streamed away northward reaching its maximum height over about position angle 80° where it seemed to settle down again towards the sun's surface. For four days, (10th to 13th), prominences, showing great changes from day to day, covered practically the same part of the limb (position angle 70°—90°). On the 30th, the day of the total eclipse, a group of four prominences about 1′ in height and joined at the tops formed a very conspicuous feature on the east limb.

*September.*—This month was a very unfavourable one for prominence work. There were four prominences seen of 100 seconds and upwards. One of these seen on the 10th was a slender arch reaching to a height of 120″ and joining two points of the limb 16° apart. On the 30th one was seen 140″ high which was particularly bright in hydrogen light and very faint in calcium light.

*October.*—The daily number of prominences was rather lower than usual, especially towards the end of the month. Prominences exceeding 100″ in height were seen on four days, one on the 17th, two on the 23rd, one on the 29th, and one on the 30th. The last two were rather remarkable as they were apparently different parts of one enormous prominence. It reached a height of 165″ on the 29th and was still 140″ high on the 30th. On the 27th and 28th there were lower prominences visible at almost exactly the same latitude.

*November.*—Prominences were fairly numerous. Four were observed of a height exceeding 100″, one on the 4th, one on the 17th and two on the 18th There was a slightly disturbed prominence on the 3rd, at latitude + 12° west, which when first seen was 75″ high. Later it apparently rose up bodily and became quite separated from the limb. Metallic prominences were seen on the 1st, 6th, 7th and 16th.

*December.*—The prevalence of cirrus was unfavourable for prominence work. Only one prominence was seen of a height exceeding 100″. This was observed on the 17th and consisted of a group of tall slanting jets covering about 20° of the limb which attained a maximum height of 120″. Metallic prominences were observed on four days (1st, 6th, 7th, and 9th) and on three of these the prominences were associated with spots.

### (*b*) Other Observations.

13. **Time.**—Time is determined with the transit instrument when necessary. The standard clock of the observatory is also compared daily with the Madras standard clock by means of the signal sent at 4 P.M. over all the telegraph lines in India. From July 1 all time signals have been sent by Indian Standard time, 5 hours 30 minutes fast of Greenwich mean time. All observations, from the same date, have been recorded in Standard time. A time signal is given daily from this observatory by means of a flag at 10 A.M.

14. **Meteorology.**—Meteorological observations have been carried on exactly as in former years. The instruments are read at $8^h$, $10^h$, and $16^h$, local mean time. Temperature and pressure are recorded by a Richard thermograph and barograph and the mean daily temperature and pressures are obtained from the traces corrected by reference to the eye observations. The wind direction and velocity are got from a Beckley anemograph placed on a tower some little distance from the observatory. The cups and wind vane are at a higher level than the tops of the domes.

*Temperature.*—The mean temperature for the year was nearly normal, but it was slightly in defect in January and in excess in December. The shade maximum rose to 74°·7 on May 5, and the shade minimum fell to 39°·8 on January 29. The grass minimum fell to 18°·5 on December 11, which is the lowest reading which has been recorded here. The mean temperature of the year was 56°·5 and the difference between the means of the hottest and coldest months was 8°·9, which is greater than the average.

*Humidity.*—The relative humidity was above the average for the first six months of the year and below it during the second six months. The difference was large in January, July, and December. The minimum recorded was 10 per cent. on January 16.

*Wind.*—The daily wind velocity was about the average. The highest record for any one day was 709 miles on August 24. The mean direction was N.N.E. which is the same as the average.

*Rain.*—The rainfall was above average in February, August, and October, and below average in all other months. The deficiency for the whole year was about 6 inches. The heaviest fall in one day was 3·80 inches on October 9.

*Cloud and Sunshine.*—As judged by cloud observations at $8^h$, $10^h$, and $16^h$, the year was rather more cloudy than usual, but, at the same time, the number of hours of bright sunshine recorded was considerably above the average. This is probably due to the abundance of cirrus cloud which has already been referred to. Curiously enough the largest number of hours of bright sunshine was recorded in December, when there was a daily average of 8·3 hours.

The transparency of the lower atmosphere, as judged by the visibility of the Nilgiris, was slightly below the average of the last five years and much below that for 1902.

15. **Seismology.**—The Milne horizontal pendulum was in use throughout the year and the results are given in appendix I. The instrument has worked well, but the record of one large earthquake on July 9 was lost by bad driving of the paper, due to the clamp not having been properly adjusted. The first and last parts of the great Indian earthquake of April 4 were well recorded, but during the large motion the boom went completely off the scale and remained there till brought back by hand. Stops have now been placed in the box to limit the motion of the boom.

16. **Library.**—In addition to a large number of books and pamphlets received as exchanges, the library received 186 sheets of the Greenwich Astrographic Chart and 28 sheets of the French *Carte Photographique du ciel* : 171 volumes were bound during the year.

17. **Publications.**—Three bulletins were published and distributed during the year, and a fourth is in type. Bulletin No. I. gives the observations on widened lines in sunspot spectra made between January 1903 and February 1904. No. II. contains a list of prominences observed between 1903 September 1 and 1904 December 31. No. III. gives an account of the observations of $D_3$ as a dark line in the solar spectrum. No. IV. will bring the record of sunspot spectra up to the end of June 1905.

18. **General.**—The Director inspected the Madras Observatory in November. The whole staff has worked well during the year, and it is mainly due to the activity and interest shown by them that observations have been obtained on such a large number of days.

This observatory has, with the sanction of the Government of India, promised to take part in the scheme now being elaborated by the "International Union for Co-operation in Solar Research". It is intended to help both in spectroheliography and in photographic spectra of sunspots, but the latter must lie over till the arrival of the long expected assistant to the Director, as the work at present going on is quite as much as the existing staff can perform efficiently.

KODAIKÁNAL,
31*st January* 1906.

C. MICHIE SMITH,
*Director, Kodaikánal and Madras Observatories.*

## II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1905.

I was away on leave for two months from 17th May to 16th July. Mr. R. Littlehailes, Professor of Mathematics, Presidency College, acted as Deputy Director, during this period.

Mr. C. Chengalvaraya Mudaliar of the Meteorological office continued to act for Mr. M. G. Subrahmanyam, the First Assistant, who was on duty at Kodaikánal, throughout the year.

The Second Assistant took two months' privilege leave from the 23rd March.

2. **Time Service.**—The astronomical observations made during the year were, as usual, solely directed to time determinations. They were made by the Computer and the acting First Assistant. Transits of the Sun were also taken occasionally in order to check the rate of the clock when cloud or unfavourable weather prevented the regular star observations from being made.

The Government of India having sanctioned the introduction of Standard Time for India, all the time signals from the Observatory have, from 1st July 1905, been sent in accordance with this new system, which is $5\frac{1}{2}$ hours in advance of Greenwich mean time and 0 hr. 9 m. 0·4 s. in advance of Madras mean time.

The time gun at the Fort was fired correctly at noon and at 8 P.M. on 702 occasions out of 730, giving a percentage of success of 96·2.

The time ball at the Port office was dropped correctly on all occasions except one when it failed at 1 but was dropped correctly at 2 P.M.

3. **Meteorological Observations.**—Meteorological observations were made as usual, viz., at 8 hr. 10 hr., 16 hr., and 20hr. A wet minimum thermometer was brought into use and observations recorded from 1st September. The observations of 10 hr. and 16 hr. were reduced and sent to the office of the Meteorological Reporter to the Government of India, Alipore (Calcutta), on Form A till September and on Form F—a more elaborate one—from October. The record of movements of the clouds observed by means of the nephescope were also sent to that office every month. Besides the ordinary daily weather messages, special storm observations were called for and supplied to (1) Simla on one occasion and (2) Calcutta on the following dates—April 16 and 17, October 8 to 16 and 20 to 24.

The tabulation of the traces of the Barograph, Thermograph and Anemograph at Madras and of the Anemograph at Dodabetta are up to date.

4. **Buildings.**—Considerable repairs to the buildings have been effected during the year.

5. **Instruments.**—A tape chronograph by R. Feuss, Berlin, was received during the year, but has not yet been brought into use, as there is no seconds contact fitted to the Transit Clock as yet. The Transit Clock by Dent and the Chronometer by Kullberg were cleaned during the year. The rate of the Transit Clock was very variable for the greater part of the year, but has become fairly steady since it was cleaned in November. Annexed is the list of instruments at the Madras Observatory on 31st December 1905 :—

(a) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton and Simms.
Sidereal Clock—Haswall.
,, Dent No. 1408.
Electric Mean Time Clock with galvanometer—Shephard & Sons.
Meridian Circle—Troughton & Simms.
Mean Time Clock—J. Monk.
Mean Time Chronometer—V. Kullberg 5394.
,, ,, ,, 6544.
,, ,, Parkinson & Frodsham 2352.
Portable Transit Instrument—Dollond.
Portable Telescope with stand.
Tape Chronograph—R. Feuss.

(*b*) *Meteorological.*

Richard's Thermograph—No. 36188 L. Casella.
Beckley's Anemograph—Adie.
Sunshine Recorder—No. 149 L.C.
Anemoscope—P. Orr & Sons.
Nephescope—Mons. Jules Daboseq & Ph. Pellin.
Wind Resultant Indicator—G. K. Winter.
Barometer, Fortins—No. 1771 L.C.
Barometer—No. 725 L.C. (spare).
Dry bulb thermometer—No. 94221 L.C.
Dry bulb thermometer—No. 38037 Negretti and Zambra (spare).
Wet bulb thermometer—94219 L.C.
Wet bulb thermometer—38037 N. & Z. (spare).
Dry maximum thermometer—No. 8581 N. & Z.
Dry minimum thermometer—No. 69047 L.C.
Wet minimum thermometer—No. 91753 N. & Z.
Sun maximum thermometer—No. 10479 ,,
Grass minimum thermometer—No. 3377 ,,
Raingauge (8″ diameter). 1042 N. & Z.
Measure Glass for above.
Raingauge (5″ diameter).
Measure Glass for above.

6. **Weather Summary.**—The following is a summary of the meteorological and weather conditions at Madras during the year 1905 :—

*Pressure.*—The mean atmospheric pressure was normal in February and June, below normal in March, August and September and above normal during the other months. The excess in November was 0·061 inch. The highest pressure recorded was 30·230 inches on January 1, and the lowest 29·820 inches on June 14.

*Temperature.*—The mean temperature was normal in May, below normal in January, April and December and above normal during the rest of the year, the excess being 2°·8 in July and 2°·3 in September. The highest shade temperature recorded was 108°·2 on June 2 and the lowest 57°·4 on January 29. The mean maxima in June and July were 102°·4 and 100°·3, respectively, being much above the average. The greatest solar heat in vacuo was 152°·1 on September 26 and the lowest on grass 52°·8 on January 29.

*Humidity.*—Humidity was much above normal in October and almost normal in the other months, the lowest being 24 on July 24.

*Wind.*—The wind direction was normal in April, May, July, August and September. It was two points more easterly in January, November and December and three points more northerly in October. The wind velocity was deficient in all the months except February, March, July and September. The highest wind velocity on any day was 327 miles on March 21 and the lowest 65 on December 28 and 29.

*Cloud.*—The percentage of cloud was in excess in February, March and April and below normal in all the other months.

*Sunshine.*—The percentage of bright sunshine was below normal in all months except July and December.

*Rain.*—The rainfall was above the average during the first three months of the year and in October, and below during the rest of the year. The fall in October was 19·65 inches — 8·65 inches in excess of the average for the month. The north-east monsoon rainfall from October 15 to the end of the year was 17·85 inches against an average of 27·6 inches.

*Storms.*—No storm crossed the coast of Madras during the year.

MADRAS,
*7th February* 1906.

R. LL. JONES,
*Deputy Director.*

# Appendix I.

## Kodaikánal Observatory Seismological Records.

| Number. | Date. | P.T. Commence G.M.T. | L.W. Commence G.M.T. | Maxima G.M.T. | End. | Max. Amp. | Duration. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | 1905. | H. M. | H. M. | H. M. | H. M. | MM. " | H. M. | |
| 1 | Jan. 22 | 2 51·9 | 2 57·5 | 3 1·7<br>13·0 | ...<br>4 21 | 1·5 = 0·7<br>1·8 = 0·9 | ...<br>1 28 | |
| 2 | Feb. 2 | 21 13·4 | 21 14·9 | 21 16·9 | 21 31 | 0·3 = 0·2 | 0 18 | |
| 3 | 4 | 6 32·3 | 6 36·3 | 6 37·6 | 6 39 | 0·3 = 0·2 | 0 07 | |
| 4 | 13 | 5 47·3 | ... | ... | ... | ... | 0 02 | Widening of line. |
| 5 | 14 | 9 10·5 | 9 32·8 | 9 40·5<br>48·3<br>52·4 | ...<br>...<br>10 39 | 2·0 = 1·0<br>2·5 = 1·3<br>2·0 = 1·0 | ...<br>...<br>1 29 | |
| 6 | 17 | 11 46·2 | 11 51·1 | 11 52·4<br>59·6<br>12 01·8<br>05·8 | ...<br>...<br>...<br>13 10 | 1·0 = 0·5<br>1·5 = 0·7<br>1·5 = 0·7<br>1·1 = 0·6 | ..<br>...<br>...<br>1 24 | |
| 7 | 19 | 4 58·6 | ... | ... | 6 20 | ... | 1 22 | Many small maxima. |
| 8 | 27 | 17 47·3 | ... | 17 52·4 | 18 44 | ... | 0 57 | Small but well marked. |
| 9 | March 4, 5 | 23 28·9 | 23 38·0 | 23 47·2<br>0 14·9 | ...<br>0 34 | 0·4 = 0·2<br>0·5 = 0·3 | ...<br>1 05 | |
| 10 | 19 | 0 10·8 | 0 22·1 | 0 24·1<br>52·8<br>1 22·6 | ...<br>...<br>2 28 | 1·0 = 0·5<br>1·0 = 0·5<br>1·0 = 0·5 | ...<br>...<br>2 17 | |
| 11 | 22 | 4 02·7 | 4 32·6 | 4 33·5<br>38·7 | ...<br>5 32 | 0·6 = 0·3<br>0·8 = 0·4 | ...<br>1 29 | |
| 12 | April 2 | 3 28·4 | ... | ... | ... | 0·6 = 0·3 | 0 03 | Felt in Madras and north of it. |
| 13 | 4 | 0 55·6 | 1 00·8 | Lost. | 4 32 | >22 >12 | 3 36 | Boom driven off scale and caught. |
| 14 | 4 | 12 43·6 | ... | ... | ... | ... | 0 04 | |
| 15 | 7 | 4 29·7 | 4 32·8 | 4 33·3 | 4 55 | 2·0 = 0·9 | 0 25 | |
| 16 | 19 | 10 03·8 | ... | ... | 10 07 | 0·6 = 0·3 | 0 03 | |
| 17 | 19 | 12 56·6 | ... | ... | 13 55 | .. | 0 58 | Widening of line. |
| 18 | 23 | 2 36·0 | 2 37·8 | ... | 2 42 | 0·5 = 0·3 | 0 06 | |
| 19 | May 11 | 17 22·2 | ... | ... | 18 10 | ... | 0 48 | Widening of line. |
| 20 | 18 | 13 48·3 | ... | ... | 13 52 | 0·6 = 0·3 | 0 04 | Do. |
| 21 | 23 | 7 16·8 | 7 25·2 | 7 28·2<br>35·4 | ...<br>8 16 | 0·3 = 0·2<br>0·4 = 0·2 | 1 06 | |
| 22 | 31 | 18 41·6 | 18 49·3 | 18 53·4 | 19 13 | 0·9 = 0·5 | 0 31 | |
| 23 | June 2 | 5 52·4 | Lost. | Lost. | 6 31 | Lost. | 0 38 | Sheet changed 6h 02m to 6h 14m. |
| 24 | 12 | 5 41·1 | ... | ... | 6 36 | ... | 0 55 | Slight. |
| 25 | 14 | 11 54·3 | 11 57·4 | 11 58·5 | 13 19 | 0·5 = 0·2 | 1 25 | |
| 26 | 19 | 1 42·0 | ... | ... | 1 49 | ... | 0 07 | Widening of line. |
| 27 | 30 | 17 31·3 | 18 03·6 | 18 08·7<br>19·0 | ...<br>19 48 | 1·5 = 0·7<br>1·1 = 0·5 | ...<br>2 17 | |

# Kodaikánal Observatory Seismological Records—*cont.*

| Number. | Date. | | P.T. Commence G.M.T. | | L.W. Commence G.M.T. | | Maxima G.M.T. | | End. | | Max. Amp. | Duration. | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1905. | | H. | M. | H. | M. | H. | M. | H. | M. | MM. " | H. | M. | |
| 28 | July | 6 | 16 | 31·5 | 17 | 00·5 | 17 | 03·6<br>09·7 | 18<br>... | 21 | 3·0=1·3<br>2·0=0·9 | 1<br>... | 49 | |
| 29 | | 9 | .. | | ... | | ... | | ... | | ... | ... | | Very large earthquake but time uncertain as clock was driving badly. |
| 30 | | 14 | 9 | 43·3 | ? | | 9 | 55·6 | 10 | 09 | 0·4=0·2 | 0 | 26 | |
| 31 | | 14 | 22 | 25·4 | 22 | 26·0 | 22 | 26·2 | 22 | 45 | 1·1=0·6 | 0 | 20 | |
| 32 | | 16 | 18 | 56·7 | 18 | 59·6 | 19 | 02·1 | 19 | 13 | 0·8=0·3 | 0 | 16 | |
| 33 | | 17 | 0 | 47·3 | ... | | ... | | 1 | 46 | ... | 0 | 59 | ? E.Q. Widening of line. |
| 34 | | 23 | 2 | 54·6 | 3 | 03·8 | ? | | 5 | 39 | 24+=9+ | 2 | 45 | Light went off scale for some time (Chita E.Q.). |
| 35 | | 27 | 22 | 55·4 | ... | | ... | | 23 | 03 | .. | 0 | 08 | Widening of line. |
| 36 | Sept. | 8 | 1 | 52·8 | 2 | 21·7 | 2 | 22·8<br>31·0 | ...<br>3 | 43 | 1·4=0·8<br>1·0=0·5 | ...<br>2 | 50 | Italian E.Q. |
| 37 | | 8 | 5 | 33·1 | 5 | 33·1 | 5 | 33·1 | 5 | 37 | 1·0=0·5 | 0 | 04 | ? E.Q. |
| 38 | | 14 | 20 | 05·6 | ? | | 20 | 35·1<br>39·2<br>43·6 | ...<br>...<br>21 | 11 | 0·4=0·2<br>0·5=0·2<br>0·4=0·2 | ...<br>...<br>1 | 05 | |
| 39 | | 15 | 6 | 15·1 | 6 | 51·0 | 6 | 56·7 | 9 | 13 | 7·5=3·6 | 2 | 58 | |
| 40 | | 27 | 1 | 36·2 | 1 | 42·3 | 1 | 43·3 | 2 | 37 | 1·6=0·8 | 1 | 01 | |
| 41 | | 29 | 11 | 53·6 | 12 | 12·9 | 12 | 13·9 | 13 | 24 | 1·1=0·4 | 1 | 30 | |
| 42 | Oct. | 19 | 16 | 27·0 | 16 | 32·0 | 16 | 32·5 | 17 | 00 | 4·2=2·0 | 0 | 33 | |
| 43 | Nov. | 8 | 22 | 19·7 | 22 | 40·3 | 22 | 48·1 | 23 | 34 | 1·6=0·7 | 1 | 14 | |
| 44 | | 22 | 23 | 29·6 | ... | | ... | | 25 | 36 | ... | 0 | 06 | Widening of line. |
| 45 | | 22, 23 | 23 | 55·6 | 0 | 13·1 | 0 | 14·1 | 0 | 29 | 0·6=0·3 | 0 | 33 | |
| 46 | | 26 | 9 | 59·5 | 10 | 12·7 | 10 | 12·7 | 10 | 23 | 0·7=0·3 | 0 | 23 | ? E.Q. |
| 47 | Dec. | 4 | 7 | 20·3 | 7 | 32·0 | 7 | 33·6<br>37·7 | ...<br>8 | 05 | 0·6=0·3<br>0·8=0·4 | ...<br>0 | 45 | |
| 48 | | 10 | 13 | 27·9 | 13 | 33·1 | 13 | 35·1<br>37·2 | ...<br>14 | 04 | 0·5=0·2<br>0·6=0·3 | ...<br>0 | 36 | Felt in N. India. |
| 49 | | 10 | 18 | 19·4 | 18 | 30·5 | 18 | 31·0 | 19 | 02 | 0·6=0·3 | 0 | 43 | |

# Appendix II.

MEAN monthly and annual Meteorological Results at the Kodaikánal Observatory in 1905.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer Mean. | Dry bulb thermometer Max. | Dry bulb thermometer Min. | Dry bulb thermometer Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. (By Blanford's tables.) | Relative humidity. (By Blanford's tables.) | Sun Max. in Vac. | Min. on grass. | Wind. Daily velocity. | Wind. Mean direction. | Wind. Mean direction. | Rain. Amount. | Rain. Days. | Clear sky. | Bright sunshine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | POINTS. | POINTS. | INCHES. | NO. | CENTS. | HOURS. |
| January ... ... | 22·852 | 0·071 | 51·8 | 61·3 | 44·9 | 16·4 | 47·4 | 40·7 | 0·287 | 75 | 113·6 | 35·4 | 267 | 1 | N. by E. | 0·56 | 2 | 61 | 205·2 |
| February ... | ·857 | ·071 | 54·9 | 66·2 | 48·0 | 18·2 | 49·1 | 43·0 | ·293 | 67 | 124·8 | 38·7 | 308 | 6 | E.N.E. | 1·66 | 2 | 60 | 204·2 |
| March ... ... | ·857 | ·073 | 57·5 | 67·6 | 51·1 | 16·5 | 51·4 | 45·5 | ·323 | 67 | 127·5 | 41·4 | 295 | 13 | S.E. by S. | 2·34 | 5 | 61 | 221·5 |
| April ... ... | ·850 | ·071 | 58·6 | 67·3 | 53·6 | 13·7 | 54·4 | 48·7 | ·382 | 77 | 133·0 | 46·5 | 315 | 6 | E.N.E. | 3·79 | 10 | 47 | 164·2 |
| May ... ... | ·805 | ·063 | 60·7 | 69·9 | 54·8 | 15·1 | 55·4 | 50·3 | ·390 | 74 | 134·6 | 48·6 | 292 | 2 | N.N.E. | 6·52 | 9 | 47 | 206·4 |
| June ... ... | ·778 | ·056 | 58·4 | 65·5 | 54·2 | 11·3 | 54·4 | 50·7 | ·386 | 79 | 129·0 | 49·8 | 398 | 27 | N.W. by W. | 3·38 | 11 | 31 | 131·9 |
| July ... ... | ·782 | ·054 | 57·2 | 64·6 | 52·7 | 11·9 | 52·8 | 48·2 | ·359 | 76 | 126·6 | 47·3 | 389 | 28 | N.W. | 2·68 | 7 | 37 | 109·8 |
| August ... ... | ·777 | ·063 | 57·0 | 64·4 | 52·7 | 11·7 | 53·3 | 48·7 | ·373 | 80 | 127·1 | 47·7 | 323 | 27 | N.W. by W. | 8·54 | 13 | 35 | 149·6 |
| September ... | ·792 | ·071 | 56·6 | 63·8 | 52·4 | 11·4 | 53·1 | 48·8 | ·372 | 81 | 123·7 | 46·6 | 274 | 26 | W.N.W. | 7·34 | 13 | 31 | 122·0 |
| October ... ... | ·809 | ·078 | 56·3 | 63·4 | 51·4 | 12·0 | 51·3 | 48·1 | ·331 | 73 | 119·8 | 46·1 | 292 | 2 | N.N.E. | 15·36 | 14 | 47 | 166·9 |
| November ... | ·869 | ·072 | 54·2 | 60·8 | 49·5 | 11·3 | 52·2 | 47·3 | ·373 | 88 | 112·5 | 45·8 | 349 | 7 | E. by N. | 7·77 | 11 | 37 | 113·9 |
| December ... | ·837 | ·071 | 55·0 | 66·8 | 47·5 | 19·3 | 45·6 | 38·7 | ·217 | 51 | 120·8 | 36·1 | 324 | 5 | N.E. by E. | 0·02 | ... | 65 | 258·6 |
| Annual ... | 22·822 | 0·068 | 56·5 | 65·1 | 51·1 | 14·1 | 51·7 | 46·6 | 0·340 | 74 | 124·4 | 44·1 | 319 | 2 | N.N.E. | 59·96 | 97 | 47 | 2,114·2 |

EXTREME monthly Meteorological Records at the Kodaikánal Observatory in 1905.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry bulb thermometer. Highest. | | Dry bulb thermometer. Lowest. | | Wet bulb. Lowest. | | Humidity. Lowest. | | Sun Th. in Vacuo. Highest. | | Grass therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY. |
| January ... ... | 22·974 | 1 | 22·776 | 26 | 0·198 | 67·4 | 30, 31 | **39·8** | **29** | **33·2** | **18** | **10** | **16** | 121·4 | 30 | 23·2 | 16 | 588 | 2 | 165 | 10 | 0·32 | 6 |
| February ... ... | ·969 | 27 | ·780 | 17 | ·189 | 69·4 | 17 | 43·8 | 4 | 37·0 | 2 | 21 | 26 | 134·6 | 21 | 28·6 | 8 | 644 | 26 | 175 | 6 | 1·27 | 23 |
| March ... ... | **·977** | **5** | ·765 | 21 | ·212 | 73·3 | 13 | 45·9 | 6 | 36·6 | 5, 7 | 22 | 4 | 138·4 | 29 | 32·1 | 7 | 559 | 4 | 135 | 20 | 0·83 | 19 |
| April ... ... | ·936 | 27 | ·763 | 18 | ·173 | 72·5 | 27 | 51·8 | 7 | 40·5 | 9 | 35 | 9 | 144·9 | 10 | 41·4 | 7 | 656 | 17 | 194 | 3 | 0·84 | 29 |
| May ... ... | ·901 | 4 | ·699 | 22 | ·202 | **74·7** | **5** | 50·9 | 28 | 40·2 | 4 | 22 | 4 | **149·0** | **16** | 43·7 | 2 | 454 | 24 | 168 | 21 | 2·49 | 12 |
| June ... ... | ·853 | 8 | ·682 | 20 | ·171 | 70·9 | 3 | 49·7 | 12 | 43·5 | 16 | 34 | 16 | 146·0 | 6 | 44·4 | 14 | 687 | 19 | 129 | 3 | 0·41 | 19 |
| July ... ... | ·858 | 10 | ·706 | 20 | ·152 | 69·4 | 4 | 49·7 | 7 | 41·4 | 14 | 39 | 3 | 146·6 | 2 | 41·7 | 29 | 683 | 7 | 198 | 3 | 1·02 | 11 |
| August ... ... | ·872 | 6 | **·681** | **18** | ·191 | 68·4 | 6 | 50·1 | 4 | 42·4 | 10 | 36 | 10 | 144·6 | 27 | 40·4 | 6 | **709** | **24** | 119 | 6 | 1·53 | 30 |
| September ... | ·886 | 17 | ·697 | 6 | ·189 | 69·0 | 30 | 50·4 | 28 | 39·6 | 23 | 31 | 23 | 140·6 | 21 | 32·8 | 28 | 597 | 6 | **106** | **18** | 1·24 | 26 |
| October ... ... | ·891 | 4 | ·724 | 17 | ·167 | 69·0 | 1 | 46·4 | 30 | 38·7 | 25 | 34 | 24 | 143·9 | 1 | 32·6 | 30 | 499 | 7 | 177 | 13 | **3·80** | **9** |
| November ... | ·966 | 8 | ·802 | 11 | ·164 | 65·1 | 1 | 41·8 | 6 | 36·8 | 6 | 51 | 29 | 134·8 | 1 | 35·3 | 29 | 634 | 25 | 151 | 2 | 1·26 | 25 |
| December ... | ·930 | **25** | ·735 | 10 | ·195 | 73·3 | 23 | 41·7 | 11 | 33·3 | 28 | 12 | 22, 25, 28 | 131·1 | 21 | **18·5** | **11** | 597 | 16 | 144 | 21 | 0·02 | 3 |

# Appendix III.

Kodaikánal mean hourly Wind Velocity for the year 1905.

| Month. | Hours. | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| January ... ... ... | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 11 | 12 | 10 | 11 | 11 | 11 | 11 | 10 | 10 | 8 | 8 | 8 | 9 | 9 | 11 | 13 | 14 |
| February ... ... ... | 14 | 15 | 15 | 14 | 15 | 14 | 15 | 15 | 15 | 15 | 16 | 15 | 14 | 12 | 11 | 10 | 9 | 9 | 9 | 9 | 10 | 10 | 12 | 14 |
| March ... ... ... | 10 | 11 | 11 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 14 | 15 | 14 | 13 | 13 | 13 | 12 | 12 | 13 | 14 | 12 | 11 | 11 | 10 |
| April ... ... ... | 14 | 13 | 13 | 13 | 12 | 13 | 13 | 13 | 14 | 14 | 15 | 14 | 14 | 13 | 14 | 14 | 13 | 12 | 11 | 11 | 11 | 12 | 14 | 14 |
| May ... ... ... | 12 | 12 | 13 | 12 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 14 | 13 | 13 | 12 | 11 | 10 | 9 | 11 | 10 | 11 | 10 | 12 |
| June ... ... ... | 18 | 18 | 19 | 19 | 18 | 18 | 16 | 14 | 14 | 14 | 16 | 16 | 16 | 15 | 16 | 15 | 15 | 16 | 17 | 18 | 17 | 18 | 17 | 18 |
| July ... ... ... | 19 | 19 | 18 | 19 | 17 | 17 | 16 | 14 | 12 | 12 | 13 | 13 | 13 | 13 | 14 | 15 | 15 | 16 | 19 | 18 | 18 | 18 | 20 | 20 |
| August ... ... ... | 16 | 16 | 17 | 18 | 17 | 17 | 17 | 15 | 15 | 13 | 13 | 12 | 11 | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 13 | 13 | 15 |
| September ... ... ... | 12 | 12 | 13 | 12 | 13 | 13 | 13 | 11 | 11 | 11 | 11 | 11 | 11 | 10 | 11 | 10 | 10 | 10 | 11 | 12 | 11 | 11 | 12 | 12 |
| October ... ... ... | 13 | 13 | 13 | 12 | 13 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 12 | 12 | 11 | 11 | 10 | 10 | 11 | 12 | 12 | 12 | 14 | 13 |
| November ... ... ... | 15 | 15 | 14 | 15 | 16 | 14 | 16 | 15 | 14 | 15 | 16 | 15 | 14 | 13 | 12 | 12 | 12 | 14 | 14 | 15 | 15 | 15 | 15 | 15 |
| December ... ... ... | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 17 | 15 | 15 | 13 | 11 | 10 | 9 | 9 | 10 | 13 | 15 | 15 | 15 | 16 |
| Mean ... | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 13 | 13 | 13 | 14 | 14 | 13 | 12 | 12 | 12 | 11 | 11 | 12 | 13 | 13 | 13 | 14 | 14 |

# Appendix IV.

KODAIKÁNAL.—Mean hourly Bright Sunshine ~~for~~ the year 1905.

| Month. | Hours. | | | | | | | | | | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6–7 | 7–8 | 8–9 | 9–10 | 10–11 | 11–12 | 12–13 | 13–14 | 14–15 | 15–16 | 16–17 | 17–18 | |
| January ... | 0·05 | 0·71 | 0·81 | 0·84 | 0·86 | 0·78 | 0·65 | 0·57 | 0·48 | 0·49 | 0·33 | 0·04 | The total number of hours of bright sunshine was 2,114·2 or 48·3 per cent. of the maximum possible. |
| February ... | ·11 | ·79 | ·94 | 1·00 | ·95 | ·83 | ·72 | ·60 | ·56 | ·42 | ·34 | ·04 | |
| March ... | ·10 | ·82 | ·91 | 0·86 | ·80 | ·78 | ·71 | ·60 | ·53 | ·51 | ·40 | ·14 | |
| April ... | ·15 | ·64 | ·72 | ·74 | ·83 | ·75 | ·64 | ·41 | ·35 | ·30 | ·18 | ·10 | |
| May ... | ·13 | ·62 | ·82 | ·85 | ·81 | ·83 | ·73 | ·56 | ·47 | ·38 | ·35 | ·10 | |
| June ... | ·13 | ·44 | ·55 | ·60 | ·59 | ·55 | ·47 | ·39 | ·31 | ·21 | ·11 | ·05 | |
| July ... | ·18 | ·60 | ·78 | ·74 | ·71 | ·61 | ·53 | ·42 | ·36 | ·31 | ·21 | ·04 | |
| August ... | ·29 | ·69 | ·75 | ·70 | ·63 | ·51 | ·39 | ·28 | ·23 | ·15 | ·17 | ·04 | |
| September ... | ·10 | ·48 | ·55 | ·56 | ·55 | ·51 | ·42 | ·33 | ·26 | ·17 | ·10 | ·03 | |
| October ... | ·74 | ·52 | ·65 | ·64 | ·66 | ·59 | ·56 | ·50 | ·43 | ·35 | ·31 | ·10 | |
| November ... | ·02 | ·25 | ·33 | ·46 | ·48 | ·45 | ·40 | ·40 | ·46 | ·32 | ·21 | ·02 | |
| December ... | ·07 | ·71 | ·92 | ·97 | ·96 | ·93 | ·90 | ·86 | ·81 | ·74 | ·45 | ·02 | |
| Mean ... | 0·17 | 0·61 | 0·73 | 0·75 | 0·74 | 0·68 | 0·59 | 0·49 | 0·44 | 0·36 | 0·26 | 0·06 | |

# Appendix V.

KODAIKÁNAL OBSERVATORY.—Number of days in each month on which the Nilgiris were visible in 1905.

| Month. | Very clear. | Visible. | Just visible. | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January ... | 2 | 5 | 1 | 8 | 16 |
| February ... | ... | 2 | 3 | 1 | 6 |
| March ... | 1 | 2 | 4 | ... | 7 |
| April ... | 1 | 3 | 3 | 1 | 8 |
| May ... | 6 | 4 | ... | ... | 10 |
| June ... | 8 | 10 | 1 | ... | 19 |
| July ... | 1 | 5 | 1 | 1 | 8 |
| August ... | 6 | 5 | 10 | 1 | 22 |
| September ... | 5 | 6 | 4 | ... | 15 |
| October ... | 6 | 3 | 4 | ... | 13 |
| November ... | 2 | 2 | 3 | 1 | 8 |
| December ... | 7 | 15 | 6 | ... | 28 |
| Total ... | 45 | 62 | 40 | 13 | 160 |

# Appendix VI.

PROVISIONAL Monthly Meteorological Means for Kodaikánal Observatory.

| Month. | Barometer. | | Dry bulb thermometer. | | | | Wet bulb. | Tension of vapour. | Relative humidity. | Min. on grass. | Wind. | | Rain. | | Bright sunshine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reduced to 32° | Range. | Mean. | Max. | Min. | Range. | Mean. | By Blanford's tables. | | | Daily velocity. | Mean direction. | Amount. | Days. | |
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | MILES. | POINTS. | INCHES. | NO. | HOURS. |
| January ... | 22·851 | 0·072 | 53·1 | 62·6 | 46·7 | 15·8 | 47·1 | 0·267 | 66 | 38·2 | 322 | E.N.E. | 2·92 | 4 | 219·7 |
| February ... | ·868 | ·070 | 54·9 | 65·4 | 47·9 | 17·5 | 48·2 | ·272 | 62 | 39·0 | 303 | E.N.E. | 1·57 | 3 | 215·5 |
| March .. ... | ·856 | ·069 | 57·9 | 68·7 | 50·9 | 17·8 | 49·0 | ·261 | 54 | 41·7 | 326 | E. | 1·79 | 3 | 252·8 |
| April ... ... | ·835 | ·070 | 59·4 | 69·0 | 53·5 | 15·5 | 53·5 | ·352 | 69 | 46·0 | 288 | E. by N. | 4·50 | 8 | 196·9 |
| May ... ... | ·812 | ·068 | 60·1 | 68·6 | 54·6 | 14·0 | 55·2 | ·387 | 74 | 49·0 | 263 | N.N.E. | 5·37 | 13 | 187·1 |
| June ... ... | ·774 | ·058 | 57·9 | 65·0 | 53·7 | 11·3 | 54·0 | ·380 | 79 | 49·6 | 398 | N.W. | 3·63 | 11 | 127·8 |
| July ... ... | ·760 | ·056 | 56·4 | 63·1 | 52·5 | 10·6 | 53·2 | ·376 | 82 | 48·8 | 448 | N.W. | 4·27 | 12 | 107·5 |
| August ... .. | ·775 | ·063 | 56·8 | 63·8 | 52·5 | 11·3 | 53·7 | ·384 | 83 | 48·0 | 314 | N.W. by N | 5·69 | 12 | 123·4 |
| September ... | ·803 | ·073 | 56·5 | 63·7 | 52·4 | 11·0 | 54·7 | ·389 | 85 | 48·5 | 299 | N.W. by N | 7·67 | 15 | 110·8 |
| October ... | ·814 | ·076 | 55·6 | 62·6 | 51·3 | 11·3 | 52·7 | ·373 | 84 | 46·6 | 276 | N. by E. | 11·14 | 18 | 137·6 |
| November ... | ·838 | ·071 | 53·9 | 61·5 | 48·8 | 12·7 | 51·1 | ·352 | 83 | 44·0 | 260 | N.E. by N. | 5·73 | 12 | 129·1 |
| December ... | ·838 | ·072 | 53·5 | 62·2 | 47·8 | 14·5 | 48·0 | ·286 | 70 | 41·0 | 302 | N.E. | 5·41 | 7 | 185·0 |
| Year ... | 22·819 | 0·068 | 56·3 | 64·7 | 51·1 | 13·6 | 51·7 | 0·340 | 74 | 45·0 | 333 | N.N.E. | 59·69 | 118 | 1,993·2 |
| Number of years. | 6–7 | 6–7 | 6–7 | 6–7 | 6–7 | 6–7 | 6 | 6 | 6 | 6 | 5–6 | 6 | 6–7 | 6–7 | 6 |

# Appendix VII.

MEAN monthly and annual Meteorological Results at the Periyakulam Observatory in 1905.

| Month. | Barometer. | | Dry Bulb Thermometer. | | | | Wet bulb. | | Tension of vapour. | Relative humidity. | Sun Max. in Vac. | Min. on grass. | Wind. | | | Rain. | | Clear sky. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reduced to 32°. | Daily range. | Mean. | Max. | Min. | Range. | Mean. | Min. | By Blanford's tables. | | | | Daily velocity. | Mean direction. | | Amount. | Days. | |
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | POINTS. | POINTS. | INCHES. | NO. | CENTS. |
| January ... ... | 29·050 | 0·151 | 77·0 | 89·1 | 64·8 | 24·3 | 67·3 | 61·6 | 0·542 | 58 | 141·6 | 58·5 | 63·1 | 13 | S.E. by S. | 0·05 | .. | 68 |
| February . | ·011 | ·169 | 80·6 | 93·9 | 67·5 | 26·3 | 69·2 | 63·7 | ·563 | 54 | 146·9 | 61·5 | 75·2 | 11 | S.E. by E. | 0·43 | 1 | 72 |
| March .. .. | 28·964 | ·163 | 83·6 | 97·7 | 70·6 | 27·2 | 71·0 | 66·4 | ·593 | 51 | 152·2 | 65·0 | 70·3 | 14 | S.S.E. | 1·21 | 3 | 73 |
| April ... ... | ·943 | ·141 | 82·8 | 95·7 | 73·3 | 22·4 | 73·6 | 70·7 | ·706 | 63 | 155·4 | 69·7 | 58·9 | 15 | S. by E. | 5·02 | 11 | 58 |
| May ... . | ·866 | ·125 | 84·2 | 96·5 | 74·7 | 21·8 | 74·0 | 71·5 | ·706 | 61 | 153·6 | 70·8 | 74·5 | 19 | S.W. by S. | 6·84 | 6 | 55 |
| June ... ... | ·856 | ·110 | 81·8 | 93·3 | 72·9 | 20·4 | 72·5 | 70·1 | ·673 | 62 | 151·1 | 68·9 | 95·2 | 19 | S.W. by S. | 1·82 | 6 | 44 |
| July ... .. | ·873 | 117 | 82·2 | 95·4 | 71·1 | 24·4 | 70·9 | 67·3 | ·607 | 55 | 156·4 | 66·2 | 106·4 | 17 | S. by W. | 0·14 | .. | 56 |
| August ... ... | ·877 | ·118 | 81·7 | 95·7 | 71·2 | 24·4 | 71·1 | 68·0 | ·609 | 57 | 159·3 | 66·5 | 85·4 | 20 | S.W. | 0·68 | 4 | 53 |
| September ... | ·887 | ·138 | 82·1 | 94·7 | 71·7 | 23·0 | 71·6 | 68·8 | ·639 | 58 | 156·8 | 67·0 | 75·1 | 13 | S.E. by S. | 3·12 | 5 | 52 |
| October .. ... | ·937 | ·132 | 80·1 | 89·9 | 71·4 | 18·5 | 72·6 | 69·3 | ·703 | 69 | 145·5 | 67·2 | 49·0 | 17 | S. by W. | 10·66 | 11 | 54 |
| November | 29·030 | ·130 | 77·7 | 87·0 | 70·6 | 16·4 | 71·0 | 68·3 | ·673 | 71 | 139·3 | 65·7 | 52·6 | 13 | S.E. by S. | 2·17 | 7 | 43 |
| December ... | ·016 | ·140 | 74·4 | 87·5 | 62·3 | 25·2 | 65·7 | 60·2 | ·520 | 60 | 138·1 | 54·7 | 51·7 | 14 | S.S.E. | 0·06 | ... | 68 |
| Annual ... | 28·943 | 0·136 | 80·7 | 93·0 | 70·2 | 22·9 | 70·9 | 67·2 | 0·628 | 60 | 149·7 | 65·1 | 71·5 | 15 | S. by E. | 31·20 | 54 | 58 |

EXTREME monthly Meteorological Records at the Periyakulam Observatory in 1905.

| Month. | Barometer. | | | | | Dry bulb Thermometer. | | | | Wet bulb. | | Humidity. | | Sun Th. in Vacuo. | | Grass therm. | | Wind. | | | | Rain. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | | Lowest. | | Range. | Highest. | | Lowest. | | Lowest. | | Lowest. | | Highest. | | Lowest. | | Highest. | | Lowest. | | Greatest fall. | |
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY. |
| January ... .. | 29·226 | 1 | 28·892 | 25, 31 | 0·334 | 92·9 | 31 | 57·7 | 30 | 54·7 | 30 | 22 | 29 | 154·1 | 22 | 50·4 | 30 | 155·4 | 1 | 33·8 | 20 | 0·05 | 6 |
| February .. | ·158 | 27 | ·847 | 20 | ·311 | 97·1 | 26, 28 | 60·1 | 4 | 56·1 | 4 | 21 | 28 | 156·3 | 20 | 53·3 | 4 | 129·7 | 14 | 44·7 | 6 | 0·42 | 23 |
| March ... ... | ·181 | 5 | ·777 | 21 | ·404 | 101·1 | 14 | 60·5 | 5 | 57·0 | 6 | 20 | 1 | 158·9 | 30 | 53·2 | 5 | 130·0 | 31 | 44·7 | 14 | 0·78 | 20 |
| April ... ... | ·075 | 6 | ·761 | 1 | ·314 | 101·6 | 1 | 68·1 | 9 | 67·1 | 9 | 32 | 3, 4 | 164·8 | 2 | 65·9 | 9 | 130·8 | 18 | 31·0 | 13 | 1·77 | 9 |
| May ... ... | ·001 | 8 | ·701 | 19 | ·300 | 101·1 | 2 | 72·1 | 26 | 68·1 | 4 | 24 | 2 | 159·8 | 11 | 67·2 | 4 | 153·8 | 22 | 28·8 | 14 | 3·33 | 12 |
| June ... ... | 28·945 | 8,14 | ·740 | 28 | ·205 | 100·8 | 5 | 67·8 | 12 | 65·1 | 16 | 32 | 15 | 163·0 | 5 | 61·3 | 12 | 137·7 | 26 | 29·2 | 21 | 0·93 | 6 |
| July ... ... | ·965 | 10 | ·737 | 7 | ·228 | 99·5 | 24 | 65·7 | 7 | 61·2 | 7 | 29 | 25 | 164·2 | 16 | 59·3 | 7 | 157·9 | 1 | 41·7 | 20 | 0·07 | 11 |
| August ... ... | 29·008 | 6 | ·721 | 25 | ·287 | 98·9 | 9 | 66·8 | 4 | 63·7 | 11 | 29 | 7, 24 | 168·5 | 31 | 61·1 | 11 | 124·9 | 10 | 46·7 | 18 | 0·15 | 17 |
| September ... | ·024 | 17 | ·728 | 9 | ·296 | 99·1 | 29 | 67·1 | 28 | 64·2 | 28 | 23 | 28 | 168·3 | 26 | 60·7 | 28 | 128·2 | 12 | 47·6 | 16 | 1·14 | 14 |
| October ... ... | ·033 | 31 | ·787 | 17 | ·246 | 98·6 | 1 | 66·7 | 25 | 64·2 | 30 | 30 | 31 | 161·2 | 3 | 60·1 | 30 | 114·1 | 5 | 14·3 | 13 | 3·77 | 14 |
| November ... | ·143 | 8 | ·900 | 11 | ·243 | 92·7 | 2 | 62·4 | 6 | 59·9 | 6 | 37 | 6 | 151·4 | 2 | 55·0 | 6 | 84·9 | 18 | 19·3 | 16 | 0·52 | 24 |
| December ... | ·140 | 25 | ·876 | 9 | ·264 | 89·9 | 13 | 55·0 | 27 | 52·7 | 27 | 28 | 25, 28 | 152·9 | 15 | 46·0 | 27 | 94·2 | 2 | 25·8 | 7 | 0·05 | 8 |

# Appendix VIII.

ABSTRACT of the mean meteorological condition of Madras in the year 1905 compared with the average of past years.

| Mean values of | 1905. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure .. .. .. .. .. .. | 29·875 | 0·011 above. | 29·864 |
| Temperature of air .. .. .. .. .. .. .. | 82·2 | 1·1 ,, | 81·1 |
| Do. of evaporation .. .. .. .. .. .. | 75·7 | 1·2 ,, | 74·5 |
| Percentage of humidity .. .. .. .. .. .. | 73 | 1 ,, | 72 |
| Greatest solar heat in *vacuo* .. .. .. .. .. .. | 137·1 | 2·6 below. | 139·7 |
| Maximum in shade .. .. .. .. .. .. .. | 91·7 | 0·9 above. | 90·8 |
| Minimum in shade .. .. .. .. .. .. .. | 75·3 | 0·6 ,, | 74·7 |
| Do. on grass .. .. .. .. .. .. .. | 73·3 | 1·4 ,, | 71·9 |
| Rainfall since January 1st on 85 days .. .. .. .. | 42·72 | 6·30 below. | 49·02 |
| General direction of wind .. .. .. .. .. .. | S.E. | Same as | S.E. |
| Daily velocity in miles .. .. .. .. .. .. .. | 167 | 4 below. | 171 |
| Percentage of cloudy sky .. .. .. .. .. .. | 45 | 4 ,, | 49 |
| Do. of bright sunshine .. .. .. .. .. .. | 53·1 | 5·3 ,, | 58·4 |

DURATION and quantity of the wind from different points.

| From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North .. | 107 | 618 | East .. | 198 | 1,165 | South .. | 132 | 991 | West. .. | 226 | 2,310 |
| N. by E. .. | 177 | 1,114 | E. by S. .. | 384 | 2,001 | S. by W. .. | 262 | 1,805 | W. by N. .. | 230 | 2,215 |
| N.N.E. .. | 171 | 1,095 | E.S.E. .. | 316 | 1,677 | S.S.W. .. | 212 | 1,531 | W.N.W. .. | 139 | 1,326 |
| N.E. by N... | 418 | 2,745 | S.E. by E. | 519 | 3,318 | S.W. by S. | 215 | 1,412 | N.W. by W. | 125 | 994 |
| N.E. .. | 220 | 1,661 | S.E. .. | 381 | 2,720 | S.W. .. | 129 | 903 | N.W. .. | 48 | 281 |
| N.E. by E. | 299 | 1,837 | S.E. by S. | 1,272 | 10,954 | S.W. by W. | 204 | 1,390 | N.W. by N. | 55 | 238 |
| E.N.E. .. | 222 | 1,345 | S.S.E. .. | 451 | 3,439 | W.S.W. .. | 203 | 1,351 | N.N.W. .. | 122 | 631 |
| E. by N. .. | 316 | 1,696 | S. by E. .. | 284 | 2,148 | W. by S. .. | 364 | 2,958 | N. by W... | 204 | 1,033 |

There were 155 calm hours during the year. The resultant corresponding to the above numbers is represented by a S.E. by S. wind, blowing with a uniform daily velocity of 51 miles.

# Appendix IX.

MADRAS OBSERVATORY.—Number of hours of wind from each point in the year 1905.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. .. .. | 1 | 6 | 15 | 114 | 21 | 72 | 36 | 120 | 77 | 114 | 78 | 63 | 2 | 4 | 1 | .. | 1 | .. | 1 | 2 | .. | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 15 |
| February .. .. .. .. | .. | 1 | 1 | .. | .. | 17 | 28 | 61 | 22 | 100 | 59 | 192 | 36 | 101 | 3 | 3 | 3 | 6 | 7 | 7 | 2 | 4 | 3 | .. | .. | .. | .. | .. | .. | . | .. | .. | 16 |
| March .. .. .. .. | .. | .. | .. | .. | 1 | 3 | 16 | 18 | 6 | 27 | 40 | 27 | 36 | 300 | 122 | 34 | 27 | 24 | 20 | 14 | 6 | 4 | 1 | 1 | 2 | .. | .. | .. | .. | .. | .. | .. | 15 |
| April .. .. .. .. | .. | .. | .. | .. | .. | .. | 2 | 8 | 12 | 29 | 38 | 58 | 137 | 292 | 46 | 12 | 14 | 26 | 15 | 8 | 1 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 21 |
| May .. .. .. .. | 1 | 1 | .. | 2 | .. | .. | 1 | 2 | 1 | 5 | 12 | 44 | 39 | 276 | 92 | 48 | 25 | 45 | 36 | 23 | 12 | 12 | 9 | 18 | 7 | 12 | 1 | 3 | 2 | 1 | .. | 3 | 11 |
| June .. .. .. .. | .. | 1 | 1 | 1 | 2 | 2 | .. | 1 | 4 | 7 | 11 | 17 | 16 | 51 | 29 | 50 | 10 | 36 | 39 | 47 | 19 | 56 | 32 | 104 | 61 | 54 | 25 | 16 | 10 | 5 | 10 | 1 | 2 |
| July .. .. .. .. | 3 | 3 | 2 | .. | .. | 1 | .. | 2 | 2 | 7 | 4 | 27 | 27 | 53 | 36 | 41 | 13 | 25 | 19 | 25 | 21 | 28 | 51 | 104 | 79 | 82 | 42 | 20 | 3 | 4 | 7 | 8 | 5 |
| August .. .. .. .. | 2 | .. | 1 | .. | 3 | .. | 2 | 2 | 1 | 9 | 7 | 27 | 39 | 72 | 44 | 45 | 14 | 55 | 32 | 37 | 23 | 46 | 39 | 62 | 30 | 52 | 32 | 48 | 5 | 3 | 1 | 1 | 10 |
| September .. .. .. .. | .. | 2 | 2 | 2 | .. | 2 | .. | 6 | 2 | 12 | 27 | 18 | 17 | 93 | 70 | 47 | 22 | 41 | 33 | 41 | 39 | 34 | 44 | 58 | 33 | 24 | 21 | 18 | 4 | 5 | 1 | 2 | .. |
| October .. .. .. .. | 14 | 9 | 15 | 27 | 25 | 32 | 43 | 45 | 42 | 35 | 23 | 26 | 19 | 26 | 4 | 3 | 3 | 4 | 9 | 11 | 6 | 18 | 24 | 16 | 13 | 4 | 18 | 17 | 20 | 16 | 50 | 79 | 48 |
| November .. .. .. .. | 30 | 52 | 66 | 119 | 99 | 106 | 75 | 27 | 22 | 27 | 5 | 4 | 1 | .. | 1 | 1 | .. | .. | 1 | .. | .. | . | .. | 1 | 1 | 2 | .. | 2 | 3 | 3 | 20 | 50 | 2 |
| December .. .. .. .. | 56 | 102 | 68 | 153 | 69 | 64 | 19 | 24 | 7 | 12 | 12 | 16 | 12 | 4 | 3 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | 1 | 18 | 33 | 60 | 10 |
| Annual .. | 107 | 177 | 171 | 418 | 220 | 299 | 222 | 316 | 198 | 384 | 316 | 519 | 381 | 1272 | 451 | 284 | 132 | 262 | 212 | 215 | 129 | 204 | 203 | 364 | 226 | 230 | 139 | 125 | 48 | 55 | 122 | 204 | 155 |

# Appendix X.

MADRAS OBSERVATORY.—Number of miles of wind from each point in the year 1905.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. .. .. | 9 | 73 | 117 | 776 | 164 | 401 | 225 | 496 | 397 | 517 | 372 | 310 | 11 | 27 | 7 | .. | 3 | .. | 4 | 9 | .. | 4 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3922 |
| February .. .. .. .. | .. | 3 | 6 | .. | .. | 118 | 161 | 423 | 192 | 535 | 342 | 1016 | 190 | 760 | 10 | 20 | 12 | 36 | 42 | 55 | 6 | 28 | 7 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3962 |
| March .. .. .. .. .. | .. | .. | .. | .. | 15 | 20 | 74 | 76 | 53 | 129 | 197 | 211 | 324 | 2841 | 976 | 310 | 233 | 222 | 161 | 78 | 58 | 31 | 4 | 4 | 11 | .. | .. | .. | .. | .. | .. | .. | 6028 |
| April .. .. .. .. .. | .. | .. | .. | .. | .. | .. | 18 | 71 | 97 | 149 | 233 | 474 | 911 | 2317 | 341 | 101 | 107 | 139 | 98 | 51 | 5 | 5 | .. | .. | .. | .. | .. | . | .. | .. | .. | .. | 5117 |
| May .. .. .. .. .. | 11 | 11 | .. | 17 | .. | .. | 13 | 24 | 9 | 58 | 90 | 394 | 395 | 2428 | 752 | 408 | 185 | 342 | 309 | 174 | 109 | 102 | 46 | 115 | 69 | 74 | 8 | 29 | 13 | 5 | .. | 46 | 6236 |
| June .. .. .. .. .. | .. | 6 | 10 | 10 | 15 | 12 | .. | 8 | 39 | 47 | 77 | 138 | 136 | 531 | 258 | 389 | 83 | 298 | 297 | 346 | 132 | 417 | 281 | 1071 | 722 | 558 | 274 | 141 | 83 | 19 | 56 | 2 | 6486 |
| July .. .. .. .. .. | 16 | 21 | 12 | .. | .. | 3 | .. | 11 | 12 | 28 | 22 | 230 | 220 | 471 | 294 | 314 | 98 | 163 | 115 | 170 | 130 | 195 | 373 | 857 | 880 | 940 | 518 | 196 | 23 | 17 | 35 | 38 | 6402 |
| August .. .. .. .. | 13 | .. | 10 | .. | 20 | .. | 22 | 11 | 9 | 82 | 65 | 229 | 269 | 582 | 321 | 518 | 100 | 334 | 210 | 213 | 151 | 278 | 215 | 341 | 207 | 404 | 258 | 396 | 24 | 17 | 10 | 2 | 5111 |
| September .. .. .. .. | .. | 18 | 11 | 9 | .. | 16 | .. | 42 | 12 | 99 | 155 | 131 | 117 | 762 | 437 | 266 | 157 | 249 | 251 | 274 | 283 | 241 | 312 | 493 | 365 | 188 | 199 | 165 | 38 | 47 | 6 | 10 | 5353 |
| October .. .. .. .. | 68 | 54 | 55 | 85 | 134 | 150 | 250 | 277 | 168 | 192 | 77 | 123 | 98 | 207 | 26 | 17 | 13 | 22 | 41 | 42 | 29 | 89 | 113 | 76 | 52 | 15 | 69 | 58 | 87 | 58 | 281 | 342 | 3368 |
| November .. .. .. .. | 118 | 309 | 455 | 902 | 851 | 736 | 442 | 167 | 134 | 116 | 16 | 23 | 1 | .. | 6 | 5 | .. | .. | 3 | .. | .. | .. | .. | 1 | 4 | 6 | .. | 6 | 11 | 14 | 84 | 221 | 4631 |
| December .. .. .. .. | 383 | 619 | 419 | 946 | 462 | 381 | 140 | 90 | 43 | 49 | 31 | 39 | 48 | 28 | 11 | .. | .. | .. | .. | . | .. | .. | .. | .. | .. | .. | .. | 3 | 2 | 61 | 159 | 372 | 4286 |
| Annual .. | 618 | 1114 | 1095 | 2745 | 1661 | 1837 | 1345 | 1696 | 1165 | 2001 | 1677 | 3318 | 2720 | 10954 | 3439 | 2148 | 991 | 1805 | 1531 | 1412 | 903 | 1380 | 1361 | 2958 | 2310 | 2215 | 1326 | 994 | 281 | 238 | 631 | 1033 | 60902 |

# Appendix XI.

Madras Observatory.—Number of inches of rain from each point in the year 1905.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. .. | .. | 0·08 | 0·24 | 0·78 | .. | 0·34 | 0·48 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| February .. .. .. | .. | .. | .. | .. | .. | .. | .. | 0·18 | .. | .. | .. | 0·07 | 0·06 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| March .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·16 | .. | .. | 0·18 | .. | .. | 0·44 | 0·01 | .. | 0·16 | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| April .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·04 | .. | 0·05 | .. | 0·25 | 0·22 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| May .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·03 | 0·02 | .. | .. | .. | .. | 0·01 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| June .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·06 | .. | 0·04 | 0·01 | 0·08 | 0·05 | .. | 0·13 | 0·14 | 0·07 | 0·09 | 0·09 | 0·10 | 0·07 | .. | 0·05 | .. |
| July .. .. .. | 0·41 | .. | .. | .. | .. | 0·01 | .. | .. | .. | .. | .. | .. | 0·06 | 0·09 | 0·11 | .. | 0·14 | 0·03 | 0·03 | 0·04 | .. | 0·26 | 0·06 | 0·14 | 0·40 | 0·06 | 0·05 | 0·21 | .. | .. | 0·04 | 0·17 | .. |
| August .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·02 | 0·68 | .. | 0·05 | 0·19 | 0·01 | 0·12 | .. | 0·07 | 0·15 | 0·02 | 0·19 | 0·53 | 0·41 | .. | .. | .. | .. | 0·08 | .. |
| September .. .. | .. | .. | | .. | .. | .. | .. | .. | 0·0[illegible] | 0·05 | 0·89 | 0·67 | 0·01 | .. | 0·01 | 0·05 | .. | 0·01 | 0·08 | 0·03 | 0·43 | 0·06 | .. | .. | .. | 0·19 | 0·02 | .. | .. | .. | .. | 0·23 | .. |
| October .. .. .. | 0·01 | 0·32 | 0·41 | 0·78 | 0·51 | 0·68 | 0·26 | 1·42 | 0·23 | 0·35 | 0·16 | 0·05 | .. | .. | .. | .. | .. | .. | 0·76 | 0·95 | .. | 0·45 | 0·03 | 0·67 | .. | 0·08 | 0·04 | 0·03 | 0·03 | 1·70 | 5·05 | 4·53 | 0·15 |
| November .. .. | 0·90 | 0·78 | 0·29 | 1·21 | 0·13 | 1·75 | 1·20 | 0·18 | 0·92 | 0·49 | 0·22 | 0·20 | .. | .. | .. | 0·27 | .. | .. | 0·31 | .. | .. | .. | .. | .. | 0·67 | .. | .. | 0·06 | .. | .. | 0·65 | 0·76 | .. |
| December .. .. | 0·17 | 0·03 | 0·03 | .. | .. | .. | .. | 0·01 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·11 | .. | 0·05 | .. |
| Annual .. | 1·49 | 1·21 | 0·97 | 2·77 | 0·64 | 2·78 | 1·94 | 1·79 | 1·23 | 0·89 | 1·32 | 0·99 | 0·38 | 0·33 | 0·39 | 0·34 | 0·25 | 0·41 | 1·23 | 1·15 | 0·96 | 0·90 | 0·24 | 1·12 | 1·40 | 0·93 | 0·61 | 0·39 | 0·13 | 1·88 | 5·74 | 5·87 | 0·15 |

# Appendix XII.

MADRAS OBSERVATORY.—Wind, cloud and bright sunshine.

| Month. | Wind resultant. | | Clouds (0—10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H. | 16 H. | 20 H. | Mean. | Average per day. | Greatest number of hours in a day. |
| | MILES. | | | | | | | HOURS. | |
| January .. .. .. .. | 106 | E. by N. | 2·1 | 3·2 | 2·5 | 1·3 | 2·3 | 7·4 | 9·3 |
| February .. .. .. | 121 | E.S.E. | 3·2 | 4·3 | 1·9 | 1·8 | 2·8 | 8·5 | 9·8 |
| March .. .. .. .. | 174 | S.E. by S. | 3·8 | 4·2 | 2·9 | 2·2 | 3·3 | 7·3 | 10·1 |
| April .. .. .. .. | 151 | S.E. by S. | 5·1 | 4·6 | 4·3 | 3·0 | 4·3 | 7·7 | 10·8 |
| May .. .. .. .. | 169 | S.S.E. | 4·6 | 3·5 | 3·9 | 3·0 | 3·8 | 6·8 | 10·6 |
| June .. .. .. .. | 128 | S.W. by W. | 4·9 | 4·4 | 6·3 | 5·5 | 5·3 | 5·4 | 8·2 |
| July .. .. .. .. | 117 | S.W. by W. | 5·2 | 4·5 | 6·8 | 7·2 | 5·9 | 5·6 | 8·0 |
| August .. .. .. .. | 81 | S.W. by S. | 5·8 | 5·7 | 6·4 | 5·0 | 5·8 | 5·0 | 10·0 |
| September .. .. | 96 | S.S.W | 5·8 | 5·2 | 6·3 | 5·6 | 5·7 | 5·0 | 9·6 |
| October .. .. .. .. | 33 | N.E. | 5·5 | 5·4 | 5·8 | 4·4 | 5·3 | 5·8 | 10·2 |
| November .. .. .. | 136 | N.E. | 5·7 | 6·2 | 5·7 | 5·4 | 5·8 | 5·4 | 9· |
| December .. .. .. | 118 | N.N.E. | 3·5 | 3·9 | 3·4 | 2·1 | 3·2 | 7·2 | 8·6 |
| Annual .. | 51 | S.E by S. | 4·6 | 4 6 | 4·7 | 3·9 | 4·5 | 6·4 | .. |

# Appendix XIII.

MEAN monthly and annual Meteorological results at the Madras Observatory in 1905.

| | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer. Mean. | Dry bulb thermometer. Max. | Dry bulb thermometer. Min. | Dry bulb thermometer. Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. By Blandford's tables. | Relative humidity. By Blandford's tables. | Sun Max. in vac. | Min. on grass. | Wind. Daily velocity. | Wind. Mean direction. | Wind. Mean direction. | Rain. Amount. | Rain. Days. | Cloudy sky. | Bright sunshine. | Dew point. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Inches. | ° | ° | ° | ° | ° | ° | Inches. | Cents. | ° | ° | Miles. | Points. | Points. | Inches. | No. | Cents. | Hours. | ° |
| January .. .. .. | 30·013 | 0·119 | 74·3 | 83·2 | 65·2 | 18·0 | 68·8 | .. | 0·635 | 75 | 133·1 | 62·1 | 127 | 7 | E. by N. | 1·92 | 3 | 23 | 228·9 | 64·6 |
| February .. .. .. | 29·964 | ·135 | 78·5 | 87·2 | 70·0 | 17·2 | 72·4 | | ·716 | 73 | 137·8 | 67·3 | 141 | 10 | E.S.E. | 0·31 | 2 | 28 | 238·4 | 68·2 |
| March .. .. .. | ·893 | 140 | 82·2 | 90·4 | 75·2 | 15·2 | 75·8 | .. | ·807 | 73 | 139·8 | 73·3 | 194 | 13 | S E. by S. | 0·85 | 3 | 33 | 227·6 | 71·5 |
| April .. .. .. | ·870 | 123 | 83·8 | 91·6 | 77 7 | 13·9 | 77·9 | . | ·877 | 76 | 139·1 | 76·1 | 171 | 13 | S.E. by S. | 0·56 | 2 | 43 | 231·6 | 74·0 |
| May .. .. .. | ·751 | ·111 | 86 7 | 96·8 | 80·4 | 16·4 | 79·2 | .. | ·896 | 70 | 139·2 | 79·1 | 201 | 15 | S. by E. | 0·06 | 1 | 38 | 211·6 | 74·4 |
| June .. .. . | ·703 | ·126 | 88·6 | 102 4 | 82·1 | 20 3 | 78·3 | .. | ·832 | 62 | 144·3 | 80·6 | 216 | 20 | S.W. | 0·98 | 7 | 53 | 161·7 | 71·8 |
| July .. .. . | ·725 | ·123 | 87·3 | 100·3 | 80·2 | 20·1 | 77·8 | .. | ·825 | 64 | 138·2 | 78·7 | 207 | 20 | S.W. | 2·31 | 15 | 59 | 172·8 | 71·7 |
| August .. . .. | ·746 | ·124 | 84·4 | 95·4 | 77·8 | 17 6 | 77·3 | .. | ·843 | 72 | 136·9 | 76·5 | 165 | 19 | S.W. by S. | 1·92 | 11 | 58 | 154·2 | 72·6 |
| September, .. | ·765 | ·122 | 85·3 | 95·3 | 79 1 | 16·2 | 73·6 | 75·5 | ·889 | 74 | 139·3 | 77·8 | 178 | 18 | S.S.W. | 2·77 | 8 | 57 | 150·7 | 74·2 |
| October .. .. . | ·845 | ·122 | 80·9 | 88·6 | 74·9 | 13·7 | 77·2 | 74·0 | ·889 | 84 | 133·1 | 73·0 | 109 | 4 | N E. | 19·65 | 15 | 53 | 180·5 | 74·7 |
| November .. .. .. | ·984 | ·106 | 79·4 | 85·8 | 73 7 | 12·1 | 75·1 | 72·3 | ·817 | 81 | 133·2 | 71·7 | 154 | 4 | N.E. | 10·99 | 16 | 58 | 160·5 | 72·1 |
| December .. .. . | ·981 | ·121 | 74·8 | 83 5 | 67·2 | 16·3 | 69·7 | 65·9 | ·662 | 76 | 131·3 | 63·4 | 138 | 4 | N.E. | 0·40 | 2 | 32 | 223·9 | 66·0 |
| Annual .. | 29·853 | ·123 | 82 2 | 91·7 | 75·3 | 16 4 | 75·7 | .. | 0·807 | 73 | 137·1 | 73·3 | 167 | 12 | S.E. | 42·72 | 85 | 45 | 2342·4 | 71·3 |

EXTREME monthly Meteorological records at the Madras Observatory in 1905.

| | Barometer. Highest. | Barometer. Highest. Day. | Barometer. Lowest. | Barometer. Lowest. Day. | Barometer. Range. | Dry bulb thermometer. Highest. | Dry bulb thermometer. Highest. Day. | Dry bulb thermometer. Lowest. | Dry bulb thermometer. Lowest. Day. | Wet bulb. Lowest. | Wet bulb. Lowest. Day. | Humidity. Lowest. | Humidity. Lowest. Day. | Sun Th. in vacuo. Highest. | Sun Th. in vacuo. Highest. Day. | Grass therm. Lowest. | Grass therm. Lowest. Day. | Wind. Highest. | Wind. Highest. Day. | Wind. Lowest. | Wind. Lowest. Day. | Rain. Greatest fall. | Rain. Greatest fall. Day. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Day. | Inches. | Day. | Inches. | ° | Day. | ° | Day. | ° | Day. | Cents. | Day. | ° | Day. | ° | Day. | Miles. | Day. | Miles. | Day. | Inches | Day. |
| January .. .. .. | 30·230 | 1 | 29·871 | 30 | 0·359 | 87·2 | 24 | 57·4 | 29 | .. | .. | 36 | 28 | 140·8 | 27 | 52·8 | 29 | 243 | 1 | 71 | 13 | 1·52 | 7 |
| February .. .. .. | ·096 | 3 | ·805 | 7 | ·291 | 91·3 | 27 | 62·0 | 1 | .. | .. | 50 | 2 | 149·7 | 28 | 58·4 | 1 | 178 | 7, 28 | 97 | 1 | 0·18 | 13 |
| March .. . .. | ·140 | 4, 5 | ·663 | 21 | ·477 | 96·9 | 31 | 68·8 | 6 | .. | .. | 53 | 1, 3 | 150·0 | 9 | 65·8 | 6 | 327 | 21 | 110 | 7 | 0·45 | 30 |
| April .. .. .. | 29·995 | 6 | ·721 | 21 | 274 | 94·7 | 29 | 75·3 | 25 | .. | .. | 55 | 1, 2 | 149·7 | 13 | 73·6 | 5 | 221 | 27 | 102 | 1 | 0·47 | 18 |
| May .. .. .. | ·919 | 7 | ·548 | 21, 22 | ·371 | 107·9 | 29 | 76·1 | 4 | .. | .. | 37 | 28 | 144·9 | 23 | 74·1 | 4 | 319 | 30 | 107 | 13 | 0·06 | 13 |
| June .. .. .. | ·820 | 14 | ·535 | 20 | ·275 | 108·2 | 2 | 77·2 | 17 | .. | .. | 34 | 1 | 149·8 | 14, 15 | 76·0 | 1, 17 | 299 | 19 | 172 | 26 | 0·39 | 16 |
| July .. .. .. | ·834 | 2 | ·597 | 21 | ·237 | 104·9 | 3 | 75·3 | 11 | .. | .. | 24 | 24 | 148·3 | 24 | 72·6 | 11 | 286 | 24 | 138 | 31 | 0·61 | 29 |
| August .. .. .. | ·879 | 6 | ·608 | 18 | ·271 | 101·2 | 21 | 72·7 | 2 | .. | .. | 41 | 4 | 151·3 | 21 | 71·3 | 2 | 225 | 10 | 104 | 3 | 0·60 | 29 |
| September .. .. .. | ·937 | 17 | ·582 | 6 | ·355 | 101·8 | 26 | 74·8 | 2 | 73·0 | 7, 8 | 37 | 8 | 152·1 | 26 | 73·2 | 2 | 245 | 9 | 96 | 12 | 1·55 | 1 |
| October .. .. .. | 30·020 | 5 | ·699 | 17 | ·321 | 93·7 | 28 | 66·7 | 28 | 65·9 | 28 | 35 | 27 | 145·2 | 17 | 62·2 | 28 | 193 | 13 | 70 | 6 | 4·71 | 16 |
| November .. .. .. | ·093 | 8 | ·862 | 4 | ·231 | 89·5 | 2 | 67·9 | 5 | 67·2 | 5 | 52 | 5 | 140·8 | 8 | 63·8 | 5 | 257 | 30 | 69 | 10 | 2·97 | 9 |
| December .. .. .. | ·116 | 25 | ·851 | 9 | ·265 | 86·2 | 12 | 59·2 | 10 | 58·0 | 10 | 48 | 9, 10 | 135·9 | 6 | 54·9 | 9, 10 | 248 | 1 | 65 | 28, 29 | 0·29 | 13 |

# Appendix XIV.

MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1905.

| Abnormals of | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure .. .. .. | + 0·016 | Same as | − 0·012 | + 0·046 | + 0·017 | Same as | + 0·004 | − 0·003 | − 0·033 | + 0·003 | + 0·061 | + 0·003 | + 0·011 |
| Temperature of air .. .. .. .. .. | − 0·8 | + 1·8 | + 2·2 | − 0·2 | Same as | + 2·2 | + 2·8 | + 1·1 | + 2·3 | + 0·3 | + 1·9 | − 0·7 | + 1·1 |
| Do. of evaporation .. .. .. | − 0·4 | + 1·6 | + 1·9 | + 0·3 | + 0·9 | + 1·7 | + 1·9 | + 1·3 | + 2·3 | + 1·6 | + 2·2 | − 0·9 | + 1·2 |
| Percentage of humidity .. .. .. .. | + 2 | Same as | − 1 | + 2 | + 3 | Same as | − 1 | + 2 | + 2 | + 6 | + 2 | − 1 | + 1 |
| Greatest solar heat in vacuo .. .. .. .. | − 5·3 | − 1·9 | − 0·7 | − 2·6 | − 3·8 | + 3·8 | − 0·5 | − 3·1 | − 2·0 | − 6·0 | − 4·2 | − 4·5 | − 2·6 |
| Maximum in shade .. .. .. .. .. | − 1·4 | + 0·6 | + 1·2 | − 1·3 | − 1·0 | + 4·1 | + 4·7 | + 1·7 | + 2·1 | − 0·4 | + 0·8 | − 0·1 | + 0·9 |
| Minimum in shade .. .. .. .. .. | − 2·3 | + 2·0 | + 3·1 | + 0·5 | − 0·4 | + 1·8 | + 1·7 | + 0·5 | + 2·0 | − 0·3 | + 1·4 | − 2·6 | + 0·6 |
| Do. on grass .. .. .. .. .. | − 1·0 | + 3·5 | + 4·5 | + 1·4 | + 0·2 | + 2·0 | + 2·1 | + 1·1 | + 2·8 | + 0·2 | + 2·2 | − 3·0 | + 1·4 |
| Rainfall in inches .. .. .. .. .. | + 1·03 | + 0·03 | + 0·46 | − 0·06 | − 2·06 | − 1·13 | − 1·56 | − 2·64 | − 1·92 | + 8·65 | − 2·22 | − 4·88 | − 4·88 |
| Do. since January .. .. .. .. | .. | + 1·06 | + 1·52 | + 1·46 | − 0·60 | − 1·73 | − 3·29 | − 5·93 | − 7·85 | + 0·80 | − 1·42 | − 6·30 | − 6·30 |
| General direction of wind .. .. .. .. | 2 points E. | 2 points S | 1 point S. | Same as | Same as | 1 point W. | Same as | Same as | Same as | 3 points N. | 2 points E. | 2 points F. | Same as |
| Daily velocity in miles .. .. .. .. | − 17 | + 19 | + 42 | − 20 | − 26 | − 4 | + 9 | − 9 | + 22 | − 14 | − 11 | − 45 | − 4 |
| Percentage of cloudy sky .. .. .. .. | − 14 | + 4 | + 9 | + 15 | Same as | − 11 | − 12 | − 9 | − 5 | − 6 | − 1 | − 20 | − 4 |
| Do. of bright sunshine .. .. .. | − 9·3 | − 9·3 | − 17·7 | − 10·3 | − 13·6 | − 4·6 | + 11·2 | − 1·2 | − 2·6 | − 2·7 | − 5·4 | + 6·7 | − 5·3 |

+ means *above* normal, − *below*.

# KODAIKÁNAL AND MADRAS OBSERVATORIES.

## REPORT FOR THE YEAR 1906.

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### I.—Kodaikánal Observatory.



### II.—Madras Observatory.

# KODAIKÁNAL AND MADRAS OBSERVATORIES.

## I.—REPORT OF THE KODAIKÁNAL OBSERVATORY FOR THE YEAR 1906.

1. **Staff.**—The staff of the Observatory on the 31st December 1906 was as follows:—

| | |
|---|---|
| Director ... ... ... ... ... ... | C. Michie Smith, B.Sc. |
| Assistant Director ... ... ... ... | J. Evershed (*not yet joined*). |
| First Assistant ... . ... ... ... | K. V. Sivarama Aiyar, M.A. |
| Second Assistant ... ... ... ... | S. Sitarama Aiyar, B.A. |
| Third Assistant ... ... ... ... ... | G. Nagaraja Aiyar. |
| Fourth Assistant ... ... ... ... | S. Balasundaram Aiyar. |
| Writer ... .. ... ... ... ... | L. N. Krishnaswamy Aiyar. |
| Photographic Assistant ... ... ... | R. Krishna Aiyar. |

There were no changes in the staff during the year. The Fourth Assistant was absent on privilege leave for three months from January 2. Mr. Evershed is expected to join his appointment in January 1907.*

The subordinate staff of the Observatory consists of a book-binder and book-binder's boy, a mechanic, four peons and a boy peon for the dark room, and two lascars.

2. **Distribution of work.**—The Director takes charge of the spectroheliograph and is helped by the Photographic Assistant. The First, Second, and Third Assistants are also trained to use the instrument if necessary. The First, Second, and Third Assistants are in charge of the work with the Cooke equatorial (spectroscopic), the Lerebour and Secretan equatorial (visual), the photoheliograph, the transit instrument, and the seismometer. They have also to do the astronomical computing and the preparation of the observations for the press. The Fourth Assistant has charge of the clock comparisons and, with the help of the writer, is responsible for the whole of the meteorological work. The writer is responsible for the accounts, correspondence and all office records.

3. **Buildings and grounds**—(*a*) *Spectroheliograph building.*—The new moving roof for covering the siderostat, referred to in last report, is now being erected. The new roof will be much smaller than the old one. It has been constructed at the Public Works Workshops, Madras, and is of an excellent design and thoroughly rigid. The roof of the main building still leaks during heavy rain but not to a serious extent.

(*b*) *Photoheliograph building.*—The new dome for the photoheliograph was received in July 1906, but there has been much delay in its erection, which was not completed by the close of the year.

(*c*) *House for the Assistant Director.*—Work on this was begun in February, but the work has progressed with extraordinary slowness and at the close of the year not more than two-thirds of the masonry was completed.

(*d*) Only a small part of the usual annual repairs had been completed by the close of the calendar year, but it is hoped that they will all be carried out before the close of the official year. They are all small and the buildings as a whole are in good order.

(*e*) *Grounds.*—In the early part of the year the grounds were several times in danger from grass fires, but the fire lines and extensive counterfiring saved them from

* Mr. Evershed reached Kodaikánal on the 21st January 1907.

all harm. As the season was a favourable one for planting a large number of young pines and cedars were planted out and are growing well. The roads and paths were maintained in good order.

(*f*) The well from which the aermotor pumps was dry for only about two months and there was no serious difficulty in obtaining the amount of water required.

4. **Instruments.**—The following are the principal instruments belonging to the Observatory :—

Six-inch Cooke equatorial.
Six-inch Lerebour and Secretan equatorial, remounted by Grubb with a 5-inch Grubb portrait lens of 36 inches focus attached.
Spectrograph—consisting of an 11-inch polar siderostat, 6-inch Grubb lens of 40-feet focus, and a 4-inch concave grating of 10-feet focus, mounted on Rowland's plan. A plane grating with collimator and camera lenses of 8-feet focus can be substituted for the concave grating.
A rhomb with ends cut at 45° mounted on a graduated circle, can be placed in front of the slit so as to enable any part of the limb to be brought on to the slit.
Six-inch transit instrument and barrel chronograph, formerly the property of the Great Trigonometrical Survey of India.
Six-prism table spectroscope—Hilger.
Photoheliograph—Dallmeyer No. 4.
Theodolite, six-inch—Cooke.
Two phototheodolites by Steinheil for cloud photography.
Sextant.
Spectroheliograph with 18-inch siderostat and 12-inch Cooke triple achromatic lens of 20 feet focus, by the Cambridge Scientific Instrument Company, Limited.
Evershed spectroscope with three prisms for prominence and sunspot work, by Hilger.
Mean time clock, Kullberg 6326.
Sidereal clock, Shelton.
Mean time chronometer, Kullberg 6299.
Sidereal chronometer, Kullberg 6134.
Tape chronograph, Fuess.
Micrometer for measuring spectrum photographs, Hilger.
Dividing engine, Cambridge Scientific Instrument Company, Limited.
Two Balfour Stewart actinometers.
Buchanan's solar calorimeter.
Induction coil with necessary adjuncts.
Small polar siderostat.
Universal instrument.
Complete set of meteorological instruments, including Richard barograph and thermograph, and wind-recorders.
A high class screw cutting lathe by Messrs. Cooke & Sons.

*The Spectroheliograph.*—The spectroheliograph was in constant use throughout the year up to December 17 when the siderostat had to be dismounted to permit of the erection of the new moving roof. This instrument has worked very satisfactorily throughout the year. A new collimating slit and a new setting microscope were ordered in the beginning of the year, but have not yet been received from the makers. To reduce the unsteadiness of the air a tube has now been placed between the lens and the mirror with very satisfactory results. When the new moving roof is erected the siderostat will be brought much closer to the lens, and it is hoped that this will still farther improve matters. The side walls have also been raised to a height of 5 feet so as to protect the mirror, as far as possible, from the strong winds which blow at certain seasons. All mechanical work is executed very slowly here, but it is confidently hoped that the spectroheliograph will be in full working order again before the end of January. All the other instruments were in good working order at the close of the year.

## OBSERVATIONS.

### (*a*) Solar Physics.

5. The first five months of the year were on the whole favourable for solar observations, but the remainder of the year was decidedly unfavourable. There were 26 days in the year on which no observations were possible. The following table shows for each day the observations that were made :—

# Table A.

## SOLAR Observations in 1906.

A = Spots observed. B = Spot spectra. C = Prominences. D = Photoheliograms. E = Spectroheliograms.

| Date. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 .. | A B C D E | A B C D E | — | A B C D E | A B *C* D *E* | A B *C* D E | A — D E | A — — | A B C D *E* | A — C D *E* | A — C D *E* | *A* — |
| 2 .. | A B C D E | A B C D E | A — C D E | A B C D E | A B C D E | A B C D E | A B C D E | A B C D E | A B C D E | A — C D E | A — C D *E* | A B C D E |
| 3 .. | A B C D E | A B C D E | A — C D E | A — D E | A — C D — | A — *C* D E | A B C D E | A — D E | A B C D E | A — C D E | A — | A B C D E |
| 4 .. | A B *C* D E | A B C D E | A — C D E | A B C D E | A — C D E | A — *C* D *E* | A B C D E | A — D E | A *B* C D E | A — C D E | A B C D *E* | A B C D E |
| 5 .. | A — D — | A — C D E | A — C D E | A — D *E* | A — C D E | A — C D E | A — *C* D *E* | A — *C* D *E* | A — D — | A — C D E | A — C D E | A — *C* D *E* |
| 6 .. | A — C D E | A B C D E | A — C D E | A B C D E | A B C D E | A — D *E* | A — *C* D — | A B C D E | A *B* *C* D E | A — C D E | A — C D *E* | A — |
| 7 .. | A — *C* D | A B C D E | A B C D E | A B *C* D E | A B C D E | A — C D E | A *B* *C* D E | A — C D *E* | A — C D E | A — C D E | *A* — | — |
| 8 .. | A — C D E | A B C D E | A B C D E | A *B* *C* D E | A B C D E | A B C D E | A — D E | A — *C* D *E* | A — C D E | A — C D E | A — | A — |
| 9 .. | A B C D E | A B C D E | A B C D E | A B C D E | A B C D E | A — D — | A — *C* D E | A — D E | A B C D E | A — C D E | A — *C* D — | — |
| 10 .. | A B C D E | A B C D E | A B C D E | A B C D E | A — D — | A B C D E | A B C D E | A — *C* D *E* | A B C D E | A — C D E | A B C D — | *A* — D — |
| 11 .. | A B C D E | A B C D E | A B C D E | A B C D E | A B *C* D E | A B C D E | A B C D E | A — C D *E* | A B C D E | A — C D E | A — D *E* | A — C D E |
| 12 .. | A B C D E | A B C D E | A B C D E | A B C D E | A B C D E | A — D — | A B C D e | A B C D E | A *B* *C* D E | A — C D E | A — C D *E* | A — *C* D E |
| 13 .. | A B C D E | A — C D E | A B C D E | A B C D E | A B C D E | — | A B C D *E* | A — *C* D E | A B *C* D E | A — C D E | *A* — | A — D E |
| 14 .. | A — *C* D *E* | A — C D E | A B C D E | A B C D E | A B C D E | A — | — | A — D E | A B C D E | A — C D E | — | A B C D E |
| 15 .. | A B C D E | A B C D E | A B C D E | A B C D E | A B C D E | A B C D — | A — *C* D *E* | A — C D E | A B C D E | A — C D E | A — | A B *C* D E |
| 16 .. | — | A B C D E | A B C D E | A B C D E | A B C D E | A — D — | A — *C* D — | A — C D *E* | A B C D E | A — C D E | A — *C* D *E* | A B C D E |
| 17 .. | A — | A *B* *C* D E | A — D *E* | A B C D E | A B C D E | — | A — D *E* | A — C D E | A B C D E | A — | A — D *E* | A — D — |
| 18 .. | A — D — | A B C D E | A — *C* D *E* | A B C D E | A B C D E | A — D — | A — D — | A — D *E* | A — D *E* | — | A B C D *E* | A B C D — |
| 19 .. | A B C D E | A B C D E | A B C D E | A B C D E | A B C D E | A — D — | A — D — | *A* — | A — | — | A B C D E | A B C D — |
| 20 .. | A — C D E | A B C D E | A B C D E | A B C D E | A B C D E | A — *C* D — | — | A — | A — D *E* | A — | — | A *B* *C* D — |
| 21 .. | A — C D *E* | A B C D E | A *B* *C* D E | A *B* *C* D E | A B C D E | A — C D E | — | A — D — | — | A — | A — D — | — |
| 22 .. | A — C D E | A B C D E | A B C D E | A B C D *E* | A B C D E | A — C D — | A — D — | — | — | A — D *E* | A — *C* D — | A B C D — |
| 23 .. | A B C D E | A B C D *E* | A B C D E | A B C D E | A B C D E | A — D *E* | A — C D *E* | A — D — | A — | A — *C* D E | A B C D E | A B C D — |
| 24 .. | A B C D E | A B C D E | A B C D E | A — C D E | A B C D E | A B C D E | A B C D E | A — D — | A — *C* D — | A — *C* D *E* | — | A B C D — |
| 25 .. | A B C D E | A — *C* D *E* | A B C D E | A — C D E | A B C D E | A — D *E* | A — C D E | — | A — D *E* | — | A — | A B C D — |
| 26 .. | A B C D E | A B *C* D E | A B C D E | A — D — | A B C D E | A B *C* D E | A *B* *C* D E | A — D — | A — C D E | — | A B C D E | — |
| 27 .. | A B C D E | A *B* *C* D E | A B C D E | A B *C* D E | A B C D E | A — *C* D E | A — D *E* | A — | A — C D E | — | A B C D E | — |
| 28 .. | A B C D *E* | — | A B C D E | A B C D E | A *B* *C* D E | A — D E | A B *C* D E | A — D — | A — C D E | A — C D — | A B C D E | A — |
| 29 .. | A B C D E | | A *B* *C* D E | A B C D E | A B C D E | A — D *E* | — E | A B C D E | A — C D E | A — *C* D E | A — *C* D *E* | A B C D — |
| 30 .. | A B C D E | | A B C D *E* | A B *C* D E | A — D E | A B C D E | A — *C* D E | A B C D E | A — C D *E* | A — C D E | A B C D E | A B C D — |
| 31 .. | A B C D E | | A B C D E | | A B *C* D E | | A — D E | A B C D E | | A — C D E | | A B C D — |

*Note.*—Where a letter is in italics it means that on that day observations were not complete.

SOLAR Observations—Abstract.

| | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 30 | 27 | 30 | 30 | 31 | 28 | 27 | 29 | 28 | 26 | 27 | 26 | 339 |
| B | 20 | 23 | 23 | 25 | 25 | 9 | 11 | 6 | 14 | .. | 9 | 16 | 181 |
| C | 27 | 25 | 29 | 27 | 29 | 17 | 19 | 15 | 22 | 22 | 18 | 19 | 269 |
| D | 29 | 27 | 30 | 30 | 31 | 27 | 27 | 24 | 26 | 23 | 21 | 22 | 317 |
| E | 27 | 27 | 30 | 29 | 29 | 19 | 23 | 20 | 24 | 22 | 17 | 10 | 277 |

6. **Photographs of the sun** with the Dallmeyer photoheliograph were taken on 317 days against 327 in 1905. During the first five months there were only 4 days on which no photograph could be obtained. During the year it was found possible to send to Greenwich all the solar negatives except one—December 28—required to fill in the gaps in the Greenwich and Dehra Dun set of daily photographs. From the beginning of the year a copy of each sun photograph has been printed in P.O.P. These when bound in volumes will be very useful for reference and will save much handling of the original negatives.

7. **Observations of sunspots.**—The sun is examined for spots and faculæ every morning when the weather permits. The sun's image is projected on an 8-inch disc, and the positions of the spots and faculæ are marked on it. There were 26 days on which no observation of this class could be made.

8. **Sunspot spectra.**—Observations of sunspot spectra were made with the Evershed three-prism spectroscope on 181 days as against 179 days in 1905, but on 14 of these days complete observations were prevented by bad weather. These observations include a record of the most prominent widened lines and a careful examination of the behaviour of the hydrogen and helium lines in the neighbourhood of all spots. These observations are still made in the same way as in previous years, but as soon as the Committee of the International Union for Solar Research issues its final proposals they will be adopted as the guide for future work. It seemed best to make no change in the method of work while the Committee's report was still under consideration.

At the request of the Director of the Solar Physics Observatory, South Kensington, lists are made out of the 12 "most widened lines" between D and F and are forwarded to him.

9. **Prominences.**—Prominences were recorded visually on 269 days against 297 in 1905. On 53 of these days the observations were either not complete or not satisfactory on account of the weather. The record of the prominences is made round the disc on which the spots and faculæ have been projected. This record is compared next day with the photographs taken with the spectroheliograph and all prominences shown in the photograph but not in the drawing are added in blue pencil. Where there is much difference between the photograph and the drawing the differences are noted. In the case of the eruptive prominences the spectra are studied but, owing to lack of time, only the most conspicuous bright lines are recorded. All conspicuous displacements of the C line are also noted and their amounts estimated.

10. **Spectroheliograms.**—Photographs with the spectroheliograph were taken on only 277 days against 317 in 1905. This falling off was due partly to the large number of unfavourable days in the second-half of the year and partly to the fact that work with this instrument was stopped on December 17 when the siderostat had to be dismantled. Up to that date photographs were taken on every day on which it was possible to obtain them. On no less than 52 of these days, however, the results were not satisfactory owing to the state of the weather. Attempts are always made to obtain spectroheliograms even if the conditions seem very unfavourable, and surprisingly good photographs are at times obtained through clouds so thick that the

exposure required is as much as six to eight times as great as with a clear sky. The great difficulty in such cases is to get a good setting, but this difficulty will be removed when the observatory is provided with an electric installation. In all, 1,163 photographs were taken and the average quality of the negatives was distinctly better than in the previous year. On the whole the photographs of prominences seem to be rather better than those of flocculi when the sky is quite clear, but on the other hand good flocculi photographs are often obtained when the glare from thin cirrus clouds is strong enough to seriously interfere with prominence photography. The great difficulty in spectroheliograph work is to get sufficiently steady images of the sun on which to work. So far as this observatory is concerned the time during which photographs of the highest quality can be obtained is confined to a comparatively short time in the morning, and the finer the day the shorter is this time. Something has been done and more can probably still be done to lengthen this favourable period, but from the nature of the case it must always be short. Spectroheliograms taken at other times are good enough for many purposes, but cannot be expected to show the same sharpness of definition. Fortunately it is possible, under favourable conditions, to obtain the necessary photographs in a very short time. On the whole, the results for the year, though by no means perfect, are such as to show that very valuable results can be obtained here on a large number of days even in a year when the weather has been much less favourable than it is on the average.

A slightly enlarged copy of the best flocculi negative for each day is made on bromide paper. This is useful as an index and saves too much handling of the original negative. The Director of the Solar Physics Observatory, South Kensington, having asked for spectroheliograms, flocculi photographs, mostly negatives, for 245 days were sent to him and in exchange 58 positives from his prominence photographs were received.

*Summary of Results.*

11. **Sunspots.**—The following table shows the monthly number of new groups observed, the mean daily number of spots visible, and the distribution between the northern and southern hemispheres :—

| — | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups .. .. .. | 22 | 18 | 38 | 30 | 20 | 27 | 25 | 26 | 28 | 19 | 15 | 29 | 297 |
| Daily number .. .. | 4·3 | 2·9 | 6·0 | 4·8 | 4·1 | 4·7 | 7·2 | 3·6 | 4·7 | 1·8 | 2·9 | 5·3 | 4·4 |
| North .. .. .. | 16 | 12 | 20 | 21 | 15 | 18 | 15 | 15 | 20 | 12 | 9 | 18 | 191 |
| South .. .. .. | 6 | 6 | 18 | 9 | 5 | 9 | 10 | 11 | 8 | 7 | 6 | 11 | 106 |

The total number of new groups seen during the year was 297 against 295 last year. There were two days, October 13 and 17, when the visible disc was free from spots. On the latter date the weather was poor and it is possible that a small spot might have been overlooked. There were 25 days on which only one group was visible and 15 of these days were in October and November. There were eleven groups visible on March 27, April 2, and July 11. Ten groups were visible on four other days.

The distribution of the groups between the two hemispheres was again very unequal, for nearly two-thirds of the whole number of new groups appeared in the northern hemisphere. The mean daily number of groups visible varied from 1·8 in October to 7·2 in July and the average for the year was 4·4. The mean latitude of the spots was 12°·2 in the northern hemisphere and 13°·7 in the southern. There were two groups within 1° and five groups within 2° of the equator. There was a great falling-off in spot activity during October and November, but in December there was a marked recrudescence of activity.

The most important groups seen during the year were the following:—

No. 719, 739, 755 This group was first seen coming round the east limb on December 13, 1905. It remained visible during three rotations. During its second round it was considerably changed in form. It was throughout a regular-shaped spot of moderate size.

No. 745, 764 was formed on the visible surface on January 21 as a group of small spots which soon developed into a double spot of considerable size and activity. This was seen during two rotations. During its second round it consisted only of the leader which traversed the disc almost unchanged as a regular-shaped quiet spot.

No. 748, 766 appeared as a small dot on January 22 and soon developed into a moderate-sized spot. This also was seen during two rotations.

No. 750 was an irregular group of large spots that was seen from January 26 to February 7.

No. 786 was first seen on March 16 as a small streak not far distant from the eastern limb. In a few days it had changed into a large spot of regular outline. It was a very active spot.

No. 788, 820 came round the limb on March 18 and 19 as two separate spots and in two days they had coalesced into a single large spot with a double umbra. Thereafter it underwent little change and disappeared round the limb on March 30. It again returned on April 15 as two separate spots, close together, and traversed the disc almost unchanged.

No. 801 was first seen close to the east limb on March 27 as a group of very small spots but soon developed into a conspicuous group of irregular outline with a number of detached umbræ.

No. 806 came round the limb on March 31. This was a large but quiet spot.

No. 813 first appeared on the east limb on April 5. It was a group of moderately large and very active spots.

No. 846 was seen as a single dot not far from the east limb on May 10. By the 15th it had formed into a regular double-spot group with a number of small spots between the main ones. During its development the group was very disturbed.

No. 849 came round the east limb on May 19 as a train of 3 spots, the largest leading. The rear spot which was the smallest broke into small dots on the 24th and the middle one similarly broke up 2 days later. The leader alone completed its course across the disc.

No. 866, 880, 905, 924 was formed on the visible disc as a group of small dots on June 8. On June 28 when it came round again it was one of largest seen during the year. It was a single round spot of regular outline. The spectrum was undisturbed in hydrogen but there were some brilliant calcium eruptions in its neighbourhood during its second rotation. This spot went round four times and lasted for 11 weeks. During the last two rounds it had undergone very little change except a slight diminution in size.

No. 907 first appeared on July 27 as three small faint dots not far from the east limb and on the next day it was reduced to a single small dot. By the 30th it had developed into a large group. On that day the spectrum showed great disturbance. This was also one of the great spots of the year.

No. 926 was first seen on August 26 near the central meridian. It might have been formed on the 25th, which was overcast. When first seen it was already a large scattered group extending over 20° of longitude.

No. 944 came round the east limb on September 11 as a single spot of regular outline. A few days later, when near the central meridian, the group consisted of 3 moderate-sized spots with a number of small spots between them, forming a train which extended over 14° of longitude.

No. 981 was a spot of moderate size that came round the limb on November 8. It was a round and regular spot with one small companion in front and several in the rear. On the 10th the spectrum indicated considerable disturbance, in the region occupied by the group.

Nos. 987, 989, 990 were also moderate-sized spots that appeared in November.

No. 1010 was a large regular spot with a divided umbra and a few small companions which came round the limb on December 12. The spectrum showed considerable disturbance, especially on December 15.

No. 1014 was seen first on December 19 as two small dots near the central meridian. It developed very rapidly into a large group.

12. **Prominences.**—As a full list of the prominences observed is being published in the *Bulletins* of the observatory it is only necessary to give here a few notes on the more important prominences of the year.

*January.*—Prominences of 100″ and upwards were seen on 8 days. One prominence on the 8th covered 25° of the south-west limb and culminated in a peak 2 minutes high. A very striking prominence was seen on the 20th at the east limb. As observed in C light at $9^h$ $15^m$ it was 120″ high and showed motion in the line of sight. It was photographed in H light at $8^h$ $45^m$ and was then 150″ high and totally different in shape from the form sketched half an hour later. The most striking feature of this month's observations was the enormous area round the spot group 750 which seemed to be sending out prominences. There were prominences seen in this region from the 25th to the 31st. On the 30th one of them appeared in this region as a great cloud floating at a height of 70″ above the chromosphere, but the photograph showed that it was connected by thin filaments with a large prominence nearly 20° nearer the equator. Metallic prominences were observed on the 6th, 8th, and 11th.

*February.*—Large prominences appeared on the west limb at the same latitude from the 9th to the 15th. On the 10th a series of prominences, more or less connected with each other by streamers, covered nearly 45° of the west limb. On the 14th a prominence reaching to a height of at least 6 minutes (the limit of the photograph) was photographed in calcium light. Only three eruptive prominences, showing displacement of the lines in the spectrum, were observed.

*March.*—This month there were only 4 prominences that could be called "very large". The largest was photographed on the 21st. It was $3\frac{1}{2}$ minutes high and covered 25° of the sun's limb. There were seven eruptive prominences recorded and all were associated with spots.

*April.*—There were 11 prominences of 100″ and upwards but the tallest was only 150″ high. Between the 11th and 23rd a number of prominences were seen near the west end of the equator indicative of a long active region near the equator.

*May.*—This month there were 44 prominences of upwards of 1 minute in height. The tallest of the month was one photographed on the 19th in calcium light. It was 108,000 miles high and was a narrow straight jet showing fine details in its structure. Only a trace of the base was seen in Hydrogen light. It was within 10° of the sun's north pole. Four metallic prominences and 6 other prominences in which C was displaced were observed.

*June.*—The unfavourable weather rendered the prominence record very incomplete but 26 prominences were recorded of upwards of 1 minute in height of which two were $2\frac{1}{2}$ minutes high.

*July.*—This month also the poor weather that prevailed rendered prominence observations very imperfect. Nineteen large prominences were recorded but the tallest was only 90″. On the 12th two prominences showing displacement of the C line were observed. One of these, at position angle 113° was metallic and had Na and Mg lines reversed. It was close to a brilliant facular region. The other was near a spot which was just disappearing round the west limb.

*August.*—On the 15 days on which observations were possible 24 prominences of 1 minute and upwards were observed. The tallest was a tree-like prominence 2 minutes high, seen on the 12th at position angle 65°.

*September.*—Thirty-three prominences of one minute and upwards were recorded on the 22 days on which observations were possible. The tallest of these was two minutes high. It was photographed on the 6th at position angle 155°.

*October.*—Prominences were fairly abundant during the month and 27 were recorded having a height of one minute and upwards. The tallest of these was seen on the 4th at position angle 158°. It was 140″ high and was quite detached from the limb.

*November.*—Owing to unfavourable weather prominence observations were very incomplete. Fourteen prominences of or over one minute in height were observed. The tallest of these was 80″ high and was seen on the 1st at position angle 349°.

*December.*—Thirty-one large prominences, one minute and upwards in height, were recorded, and six of these were two minutes in height. The two tallest were about 150″ high. One of these was seen on the 5th at position angle 132°; the other was photographed on the 13th at position angle 186°.

(*b*) Other Observations.

13. **Time.**—Time is determined with the transit instrument when necessary. The standard clock and chronometers of the observatory are compared and rated daily. The standard clock is also compared daily with the Madras standard clock by means of the signal sent at 4 P.M. over all telegraphic lines in India. A time signal is given daily from this observatory by means of a flag at 10 A.M.

14. **Meteorology.**—Meteorological observations have been carried on exactly as in former years. The instruments are read at $8^h$, $10^h$ and $16^h$, local mean time. Temperature and pressure are recorded by a Richard thermograph and barograph and the mean daily temperature and pressures are obtained from the traces, corrected by reference to the eye observations. The wind direction and velocity are got from a Beckley anemograph placed on a tower some little distance from the observatory. The cups and wind vane are at a higher level than the tops of the domes.

*Temperature.*—The mean temperature of the year was slightly above normal. With the exception of March, which was normal, the monthly mean was in excess for the first seven months. The excess amounted to 2°·3 in February, 2°·7 in April and 2°·0 in May, which are large amounts for this station. For the last five months the mean temperature was below average, but the largest amount was 0°·6, in September. The highest shade maximum recorded was 77°·3 on April 17; and the lowest shade minimum was 41°·9 on January 13. The highest temperature in the sun was 145°·6 on June 12 and the lowest grass minimum 22°·6 on January 3.

*Humidity.*—The relative humidity was largely below normal in April and May and moderately below in June and September. It was above normal during the rest of the year.

*Wind.*—The daily wind velocity was very largely below normal in July and considerably below in January, February, and March. It was largely above normal in May and considerably above in September and November. The highest daily records were 732 miles on June 16 and 735 miles on July 20.

*Rain.*—The rainfall for the year was considerably above the average, the chief excess being in August. There were 119 days on which one-tenth of an inch and upwards fell. There was no day on which as much as 3 inches fell.

*Cloud and sunshine.*—The year was decidedly more cloudy than usual and the amount of bright sunshine registered was 100 hours below the average and 219 hours below that for 1905. The only months in which the sunshine was above average were April, May, and September: in all the other months it was below.

The transparency of the lower atmosphere, as shown by the visibility of the Nilgiris, was considerably above the average. This is probably to be accounted for by the larger rainfall.

15. **Seismology.**—The Milne horizontal pendulum was in use throughout the year and the results are given in Appendix I. The year has been remarkable for the very large number of great earthquakes which have occurred. Most of these, including those of Colombia, San Francisco, and Valparaiso, were well recorded here. Copies of the chief seismograms have been supplied as usual to the British Association Committee and all applications for copies of individual records by persons interested have at once been complied with.

16. **Library.**—The contributions to the library during the year included 204 sheets of the Greenwich Astrographic chart. One hundred and forty-three volumes were bound during the year.

17. **Publications.**—Bulletins Nos. IV to VII were published during the year and No. VIII was in type at the close of the year.

Bulletins Nos. IV and VI give the observations of sunspot spectra made between March 1904 and December 1905. No. VIII will bring the record up to the end of June 1906. Nos. V and VII contain list of prominences observed from January to December 1905.

18. **General.**—The Director-General of Observatories visited Madras and Kodaikánal in January. The Director inspected the Madras Observatory in November.

The whole of the staff of the Observatory worked well during the year; those who were responsible for the solar observations are to be congratulated on securing results on a large number of days on which the conditions were very unfavourable.

KODAIKÁNAL,
1*st February* 1907.

C. MICHIE SMITH,
*Director, Kodaikánal and Madras Observatories.*

## II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1906.

**Staff.**—Mr. M. G. Subrahmanyam, the First Assistant, who was on duty at Kodaikánal, returned on the 25th January 1906 and Mr. C. Chengalvaraya Mudaliar reverted to the Meteorological office.

Mr. S. Solomon Pillai took privilege leave for one month from 13th March 1906 and Mr. M. G. Subrahmanyam for three months from the 20th April, Mr. C. Chengalvaraya Mudaliar again acting as First Assistant on both the occcasions.

2. **Time service.**—The astronomical observations made during the year were solely directed to time determinations. Transits of the sun were taken occasionally in order to check the rate of the clock when unfavourable weather prevented the regular star observations from being made.

The time gun at the Fort was fired correctly at noon and at 8 P.M. on 708 occasions out of 730, giving a percentage of success of 97·0.

The time ball at the Port office was dropped correctly on all occasions but 3 when it failed at 1 P.M., but was dropped at 2 P.M.

3. **Meteorological observations.**—Meteorological observations were made as usual at 8, 10, 16 and 20 hours, local time. The observations of 10 and 16 hours were reduced and sent to the India Meteorological office, Alipore, on Form F. The record of movements of the clouds observed by means of the nephoscope were also sent to that office every month. Besides the ordinary daily weather messages, special storm observations were called for and supplied to (1) Simla on 3 occasions and (2) Calcutta on 128 occasions.

The tabulation of the traces of the Barograph, Thermograph, and Anemograph at Madras and of the Anemograph at Dodabetta are up to date.

4. **Buildings.**—No repairs to the buildings have been made during the year. The dome of the 8-inch equatorial leaks badly. A new dome is required to replace it, and plans and estimates for this have been submitted to the local Government in the Public Works Department for sanction.

5. **Instruments.**—A new sidereal clock by S. Riefler, Munich, was erected on the north side of the transit instrument and has been used for the transit observations from the 24th July. It has been working very satisfactorily, the rate being very constant. On one occasion, the 29th October, there was a sudden and large disturbance in the rate the cause of which has not yet been found out. Since the recovery from this its rate has been very satisfactory. The tape chronograph received during the previous year has not been brought into use as a relay, which has been ordered, is required in the clock circuit. The following is the list of instruments at the Madras Observatory on the 31st December 1906 :—

(*a*) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton & Simms.
Sidereal Clock—Haswall.
,, Dent No. 1408.
,, S. Riefler No. 61.
Mean Time Clock with galvanometer—Shepherd & Sons.
Meridian Circle—Troughton & Simms.
Mean Time Clock—J. Monk.
Mean Time Chronometer—V. Kullberg 5394.
,, ,, 6544.
,, Parkinson & Frodsham 2352.
Portable Transit Instrument—Dolland.
Portable Telescope with stand.
Tape Chronograph—R. Feuss.

(*b*) *Meteorological.*

Richard's Barograph—No. 10 L. Casella.
Richard's Thermograph—No. 3618 L. Casella.
Beckley's Anemograph—Adie.

Sunshine Recorder—No. 149 L. Casella.
Anemoscope—P. Orr & Sons.
Nephoscope—Mons. Jules Dabosoq & Ph. Pellin.
Barometer, Fortins—1771 L. Casella.
Barometer, Fortins—725 L. Casella (spare).
Barometer, Fortins—1420 L. Casella (spare).
Dry bulb thermometer—No. 94221 L. Casella.
Dry bulb thermometer—No. 38037 Negretti & Zambra (spare).
Wet bulb thermometer—No. 94219 L. Casella.
Wet bulb thermometer—No. 38037 Negretti & Zambra (spare).
Dry maximum thermometer—No. 8581 Negretti & Zambra.
Dry minimum thermometer—No. 69047 L. Casella.
Wet minimum thermometer—No. 91753 Negretti & Zambra.
Sun maximum thermometer—No. 10479 Negretti & Zambra.
Grass minimum thermometer—No. 3377 Negretti & Zambra.
Raingauge (8″ diameter)—No. 1042 Negretti & Zambra.
Measure glass for above.
Raingauge (5″ diameter).
Measure glass for above.

6. **Weather summary.**—The following is a summary of the meteorological conditions at Madras during the year 1906:—

*Pressure.*—The mean atmospheric pressure was normal in June and August, above normal in March, October, and November and below normal during the other months. The excess in March reached the value of 0·037 inch. The highest pressure recorded was 30·116 inches on January 4 and the lowest 29·477 inches on July 19.

*Temperature.*—The mean temperature of the air was above normal throughout the year, the excess amounting to 3°·0 in February. The highest shade temperature recorded was 111°·5 on May 27 and the lowest 63°·4 on December 3. The mean maximum in May was 100°·8 which was 3°·0 above the average. The highest temperature in the sun (149°·6) was recorded on May 18 and the lowest on grass was 58°·2 on December 2.

*Humidity.*—The humidity was above normal throughout the year, the lowest percentage being 33 on October 30.

*Wind.*—The wind direction was normal in July and August. It was more easterly in January, March, November and December, more westerly in September and more southerly during the other months. The wind velocity was below normal in all other months except February, April and December. The highest wind velocity on any day was 398 miles on December 26 and the lowest 56 on August 21 and September 19. The average daily defect was 40 miles in August.

*Cloud.*—The percentage of cloud was normal in June and November, above normal in January, February and December and below normal in all the other months.

*Sunshine.*—The percentage of bright sunshine was normal in July and August, and much below the average during the remaining months. There were 2,080·3 hours of bright sunshine during the year.

*Rainfall.*—The rainfall was in excess in January, February, June, July, September, and December, and in defect in the other six months, the greatest defects being 6·85 inches and 6·74 inches in October and November respectively. The greatest excess was 11·15 inches in December, when 16·43 inches were received. The north-east monsoon rainfall from October 15 to the end of the year was 27·05 inches which is very near the average (27·6 inches). The total fall for the year was 49·61 inches.

*Storm.*—A storm of moderate severity passed inland in a north-westerly direction a little to the south of Madras on the morning of December 27. This storm determined heavy rain over the north of the Presidency and the Deccan during the remaining days of the month.

MADRAS,
*28th January* 1907.

R. LL. JONES,
*Deputy Director.*

# Appendix I.

KODAIKÁNAL Observatory Seismological Records in 1906.

| No. | Date. | P.T. Commence G.M.T. | L.W. Commence G.M.T. | Maxima G.M.T. | End | Max. Amp. | Duration. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | 1906. | H. M. | H. M. | H. M. | H. M. | MM. " | H. M. | |
| 1 | Jan. 6 .. | 22 15·8 | .. | .. | 22 36 | .. | 0 20 | Widening of line. |
| 2 | 15 .. | 19 32·0 | 19 41·2 | 19 42·4 | 19 54 | 0·8 0·4 | 0 22 | |
| 3 | 21 .. | 13 58·7 | 14 06·9 | 14 08·0 | 15 09 | 2·0 1·1 | 1 10 | |
| 4 | 27 .. | 10 05·0 | 10 25·6 | 10 28·7 | 11 18 | 1·1 0·5 | 1 13 | |
| 5 | 31 .. | 15 56·7 | 16 57·7 | 17 11·0 | .. | > 22 > 10 | .. | Colombia E.Q. Boom went beyond scale. |
| | | | | 20·7 | .. | 17 8·2 | .. | |
| | | | | 25 4 | 19 20 | 15 7·2 | 3 23 | |
| 6 | Feb. 1 .. | 2 48·3 | 2 48·3 | 2 48·3 | 3 54 | 0·6 0·3 | 1 06 | |
| 7 | 10 .. | 9 13·3 | .. | .. | 9 28 | .. | 0 15 | Widening of line. |
| 8 | 18 .. | 2 25·6 | .. | .. | 2 30 | .. | 0 04 | Do. |
| 9 | 19 .. | 2 22·9 | 3 01·5 | 3 02·5 | .. | 1·0 0·5 | .. | |
| | | | | 19·8 | 5 20 | 1·3 0·7 | 2 57 | |
| 10 | 27 .. | 19 50·1 | 19 52·6 | 19 52·6 | .. | 3·8 1 6 | .. | |
| | | | | 54·6 | 20 47 | 3·6 1·5 | 0 57 | Bashahr E.Q. |
| 11 | Mar. 2 .. | 6 28·0 | 6 35·3 | 6 37·2 | 7 08 | 1·4 0·8 | 0 40 | |
| 12 | 3 .. | 9 21·3 | .. | .. | 10 25 | .. | 1 04 | Widening of line. |
| 13 | 10 .. | 6 59·7 | .. | .. | 7 40 | .. | 0 40 | Do. |
| 14 | 10 .. | 16 39·2 | .. | .. | 17 44 | .. | 1 05 | Do. |
| 15 | 13 .. | 14 02·0 | 14 06·2 | 14 07·0 | 14 21 | 0·4 0·2 | 0 19 | |
| 16 | 16 .. | 22 56·7 | 23 10·0 | 23 12·1 | 23 38 | 1·5 0·8 | 0 41 | Formosa E.Q. |
| 17 | 19 .. | 8 16·0 | .. | .. | 9 01 | .. | 0 45 | Widening of line. |
| 18 | 20 .. | 3 53·6? | 4 06 0 | 4 06·8 | 4 21 | 0·5 0·3 | 0 27 | |
| 19 | 21–22. | 23 57·7 | .. | .. | 0 13 | .. | 0 15 | Widening of line. |
| 21 | 28 .. | 18 50·6 | 18 54·7 | 18 59·9 | .. | 0·4 0·2 | .. | |
| | | | | 19 11·2 | 19 41 | 0·4 0·2 | 0 50 | |
| 22 | Apr. 5 .. | 22 38·2 | 22 48·5 | 22 49·3 | 23 03 | 0·4 0·2 | 0 25 | |
| 23 | 3 .. | 18 15·8 | .. | .. | 18 39 | .. | 0 23 | Widening of line. |
| 24 | 13 .. | 19 34·9 | 19 38·2 | 19 40·3 | .. | 0·5 0·2 | .. | |
| | | | | 42·3 | 20 13 | 0·5 0·2 | 0 38 | Formosa. |
| 25 | 14 .. | 0 09·4 | 0 19·7 | 0 24·3 | 0 48 | 0·6 0·3 | 0 39 | |
| 26 | 14 .. | .. | 4 21·5 | 4 23·0 | 4 33 | 0·5 0·2 | ? | |
| 27 | 18 .. | 13 31·6 | 14 24·6 | 14 28·8 | .. | 2·2 1·2 | .. | |
| | | | | 33·1 | 16 02 | 2·5 1·4 | 2 30 | San Francisco. |
| 28 | 19 .. | 7 17·4 | .. | .. | 7 26 | .. | 0 09 | Widening of line. |
| 29 | 25 .. | ? | 1 50·7 | 1 50·9 | 2 10 | 0·4 0·3 | ? | |
| 30 | 29 .. | *16 44·0 | 16 49·5 | 16 50·3 | 17 46 | 1·9 1·0 | 1 02 | * Possibly 2nd phase. |
| 31 | May 2 .. | 1 44·6 | .. | .. | 1 48 | .. | 0 03 | Widening of line. |
| 32 | 3 .. | 8 31·5 | 8 32·1 | 8 34·1 | 8 42 | 0·5 0·2 | 0 10 | |
| 33 | 12 .. | 5 53·4 | 6 02·5 | 6 02·5 | 6 24 | 0·8 0·4 | 0 31 | Time slightly uncertain. |

## Kodaikánal Observatory Seismological Records in 1906—*cont.*

| Number. | Date. | P.T. Commence G.M.T. | | L.W. Commence G.M.T. | | Maxima G.M.T. | | End G.M.T. | | Max. Amp. | | Duration. | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1906. | H. | M. | H. | M. | H. | M. | H. | M. | MM. | " | H. | M. | |
| 34 | May 19 .. | 23 | 20·9 | .. | | .. | | 23 | 38 | .. | | 0 | 17 | Widening of line. |
| 35 | 27 .. | 6 | 11·0 | .. | | .. | | 6 | 28 | .. | | 0 | 17 | Do. |
| 36 | June 1 .. | 5 | 21·3 | Lost. | | Lost. | | 7 | 35 | 1·4 | 0·7 | 2 | 14 | Sheet marked at 6 hours 17 minutes. |
| 37 | 10 .. | 20 | 51·5 | 20 | 59·0 | 21 | 00·8 | .. | | 1·1 | 0·5 | .. | | |
| | | | | | | | 02·6 | 21 | 37 | 1·2 | 0·6 | 0 | 45 | |
| 39 | 19 .. | 11 | 31·5 | 11 | 56·7 | 11 | 57·7 | 12 | 52 | 0·6 | 0·3 | 1 | 20 | |
| 40 | 24 .. | 11 | 22·3 | 11 | 30·0 | 11 | 32·0 | .. | | 3·0 | 1·6 | .. | | |
| | | | | | | | 42·8 | 12 | 52 | 2·0 | 1·1 | 1 | 30 | |
| 41 | July 10 .. | 20 | 00·8 | .. | | .. | | 20 | 14 | .. | | 0 | 13 | Widening of line. |
| 42 | 14 .. | 0 | 45·2 | 0 | 52·6 | 0 | 53·7 | .. | | 0·5 | 0·2 | .. | | |
| | | | | | | | 57·8 | 1 | 12 | 0·6 | 0·3 | 0 | 27 | |
| 43 | Aug. 10 .. | 4 | 07·6 | 4 | 10·1 | 4 | 10·8 | 4 | 14 | 0·5 | 0·2 | 0 | 6 | |
| 44 | 15 .. | 22 | 26·5 | .. | | .. | | 22 | 33 | .. | | 0 | 6 | Widening of line. |
| 45 | 17 .. | 0 | 25·6 * | 0 | 59·9 | 1 | 03·0 | .. | | 12·0 | 5·1 | .. | | * No first P.Ts. |
| | | | | | | | 08·1 | .. | | 11·0 | 4·7 | .. | | |
| | | | | | | | 13·3 | .. | | 9·0 | 3·8 | .. | | Valparaiso E.Q. |
| | | | | | | 2 | 02·4 | .. | | 21·0 | 8·9 | .. | | |
| | | | | | | | 07·9 | .. | | 8·0 | 3·4 | .. | | |
| | | | | | | | 10·2 | 4 | 46 | 7·0 | 3·0 | 4 | 20 | |
| 46 | 17 .. | 7 | 14·8 | .. | | .. | | 7 | 30 | .. | | 0 | 15 | Widening of line. |
| 47 | 17 .. | 10 | 19·8 | .. | | .. | | 10 | 36 | .. | | 0 | 16 | Do. |
| 48 | 17 .. | 14 | 04·6 | .. | | .. | | 14 | 23 | .. | | 0 | 18 | Do. |
| 49 | 18 .. | 7 | 15·4 | 7 | 53·4 | 8 | 01·5 | 8 | 24 | 0·6 | 0·2 | 1 | 9 | |
| 50 | 19 .. | 10 | 18·3 | 10 | 48·3 | 10 | 58·2 | 11 | 27 | 0·6 | 0·2 | 1 | 9 | Beginning and end faint and doubtful. |
| 50a | 25 .. | 12 | 08·1 | .. | | .. | | 12 | 46 | .. | | 0 | 38 | Widening of line. |
| 51 | 25 .. | 14 | 01·5 | 14 | 08·6 | 14 | 10·7 | .. | | 2·4 | 1·1 | .. | | |
| | | | | | | | 12·7 | .. | | 1·5 | 0·7 | .. | | |
| | | | | | | | 14·2 | .. | | 1·5 | 0·7 | .. | | |
| | | | | | | | 17·8 | 15 | 50 | 1·1 | 0·5 | 1 | 48 | |
| 52 | 26 .. | 6 | 09 0 | .. | | .. | | 7 | 43 | .. | | 1 | 34 | Widening of line. |
| 53 | 30 .. | 2 | 57·6 | 4 | 03·7 | 4 | 09·3 | 4 | 54 | 0·5 | 0·2 | 1 | 56 | Tacna and Arica. |
| 54 | 31 .. | 15 | 02·8 | 15 | 06·9 | 15 | 06·9 | 15 | 37 | 0·6 | 0·3 | 0 | 34 | |
| 55 | Sept. 6 .. | 19 | 27·5 | .. | | .. | | .. | | .. | | 0 | 2 | Widening of line. |
| 56 | 7 .. | 19 | 01·1 | 19 | 33·0 | 19 | 35·1 | .. | | 0·6 | 0·3 | .. | | |
| | | | | | | | 40·4 | .. | | 0·5 | 0·2 | .. | | |
| | | | | | | | 42·3 | .. | | 0·7 | 0·3 | .. | | |
| | | | | | | | 46·3 | 20 | 43 | 0·5 | 0·2 | 1 | 42 | |
| 57 | 14 .. | 16 | 16·6 | 16 | 25·9 | 16 | 44·5 | .. | | 1·5 | 0·7 | .. | | |
| | | | | | | | 57·4 | .. | | 1·6 | 0·8 | .. | | |
| | | | | | | 17 | 02·6 | 18 | 57 | 1·5 | 0·7 | 2 | 40 | |

## Kodaikánal Observatory Seismological Records in 1906—*cont.*

| No. | Date. | P.T. Commence G.M.T. | | L.W. Commence G.M.T. | | Maxima G.M.T. | | End G.M.T. | | Max. Amp. | | Duration. | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1906. | H. | M. | H. | M. | H. | M. | H. | M. | MM. | " | H. | M. | |
| 58 | Sept. 17 .. | 8 | 59·9 | .. | | .. | | 9 | 54 | .. | | 0 | 54 | Widening of line. Transcaucasia. |
| 59 | 28 .. | 15 | 55·4 | 16 | 07·6 | 16 | 08·7 | 16 | 25 | 0·4 | 0·2 | 0 | 30 | |
| 60 | Oct. 2 .. | 2 | 05·0 | 2 | 41·8 | 3 | 11·2 | 4 | 59 | 2·3 | 1·1 | 2 | 54 | |
| 61 | 2 .. | 14 | 53·4 | 15 | 23·3 | 15 | 34·1 | 16 | 25 | 0·4 | 0·2 | 1 | 32 | |
| 62 | 6 .. | 12 | 49·0 | 12 | 51·5 | 12 | 52·6 | 13 | 29 | 0·6 | 0·3 | 0 | 40 | |
| 63 | 10 .. | 1 | 47·6 | 1 | 51·7 | 1 | 52·6 | 2 | 03 | 0·5 | 0·3 | 0 | 15 | |
| 64 | 10 .. | 13 | 04·1 | 13 | 23·8 | 13 | 25·3 | .. | | 0·6 | 0·4 | .. | | |
| | | | | | | | 28·9 | 14 | 04 | 0·5 | 0·3 | 1 | 00 | |
| 65 | 10, 11. | 23 | 27·7 | 23 | 38·2 | 23 | 41·0 | .. | | 0·6 | 0·4 | .. | | |
| | | | | | | | 46·5 | 0 | 13 | 0·5 | 0·3 | 0 | 45 | |
| 66 | 17 .. | 9 | 56·8 | ? | | 10 | 30·5 | 10 | 48 | 0·6 | 0·4 | 0 | 51 | |
| 67 | 24 .. | 14 | 53·1 | 14 | 57·4 | 15 | 01·6 | 16 | 05 | 21 | 10·1 | 1 | 12 | |
| 68 | Nov. 12 .. | 17 | 45·6 | .. | | .. | | 17 | 59 | .. | | 0 | 13 | Widening of line. |
| 69 | 19 .. | 7 | 25·4 | 7 | 32·6 | 7 | 44·0 | 9 | 33 | 4·2 | 2·6 | 2 | 08 | |
| 70 | Dec. 19 .. | 1 | 40·2 | .. | | 1 | 44·3 | .. | | 0·5 | 0·3 | .. | | |
| | | | | | | 2 | 23·1 | 2 | 46 | 0·6 | 0·3 | 1 | 06 | Kopal E.Q. |
| 71 | 22 .. | 18 | 27·0 | 18 | 37·1 | 18 | 42·2 | 20 | 15 | 5·0 | 2·7 | 1 | 48 | |
| 72 | 23 .. | 17 | 45·2 | 18 | 19·8 | 18 | 24·4 | 18 | 48 | 1·4 | 0·8 | 1 | 03 | |
| 73 | 26 .. | 6 | 12·7 | .. | | .. | | 6 | 58 | .. | | 0 | 45 | Widening of line. |

## Mean monthly and annual Meteorological Results at the Kodaikánal Observatory in 1906.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer. Mean. | Dry bulb thermometer. Max. | Dry bulb thermometer. Min. | Dry bulb thermometer. Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. By Blanford's tables. | Relative humidity. By Blanford's tables. | Sun Max. *in vac.* | Min. on grass. | Wind. Daily velocity. | Wind. Mean direction. | Wind. Mean direction. | Rain. Amount. | Rain. Days. | Clear sky. | Bright sun-shine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES | CENTS. | ° | ° | MILES. | POINTS. | POINTS. | INCHES. | NO. | CENTS. | HOURS. |
| January .. | 22·852 | 0·069 | 54·4 | 64·8 | 48·1 | 16·7 | 48·9 | 41·9 | 0·296 | 70 | 120·3 | 39·6 | 291 | 7 | E. by N. | 4·10 | 4 | 66 | 217·2 |
| February .. | ·850 | ·070 | 57·2 | 67·3 | 50·7 | 16·6 | 51·2 | 44·0 | ·321 | 68 | 127·2 | 38·6 | 222 | 22 | W. S. W. | 3·37 | 4 | 60 | 202·5 |
| March .. | ·878 | ·071 | 57·9 | 69·0 | 50·7 | 18·3 | 50·2 | 43·0 | ·289 | 60 | 130 9 | 40·7 | 286 | 7 | E. by N. | 2·79 | 4 | 67 | 242·9 |
| April .. | ·854 | ·065 | 62·1 | 73·8 | 54·8 | 19·0 | 52·6 | 45·8 | ·306 | 55 | 136·2 | 42·8 | 292 | 10 | E. S. E. | 2·73 | 5 | 66 | 233·2 |
| May .. | ·821 | ·071 | 62·1 | 71·1 | 56·4 | 14·7 | 55 5 | 50·1 | 376 | 67 | 133·0 | 49·3 | 286 | 4 | N. E. | 4·10 | 9 | 56 | 238·1 |
| June .. | ·768 | ·057 | 58·4 | 65·6 | 53·8 | 11·8 | 54·0 | 49·8 | ·375 | 77 | 125·3 | 48·5 | 357 | 26 | W. N. W. | 2·06 | 10 | 22 | 90·5 |
| July .. | ·739 | ·056 | 56·9 | 63·6 | 53·3 | 10·3 | 53·8 | 50·1 | ·386 | 83 | 121·2 | 50·0 | 407 | 29 | N. W. by N. | 6·89 | 13 | 23 | 94·5 |
| August .. | ·761 | ·069 | 56·3 | 62·5 | 52·5 | 10·0 | 54·4 | 50·8 | ·406 | 89 | 118·5 | 49·2 | 331 | 31 | N. by W. | 12·44 | 19 | 21 | 90·1 |
| September .. | ·781 | ·069 | 55·9 | 62·8 | 51·4 | 11·4 | 52·5 | 48·0 | ·363 | 81 | 124·2 | 46·5 | 342 | 30 | N. N. W. | 4·93 | 8 | 37 | 134·4 |
| October .. | ·813 | ·078 | 55·5 | 62·6 | 51·6 | 11·0 | 53·6 | 49·8 | ·398 | 89 | 115·1 | 46·9 | 268 | 7 | E. by N. | 7·00 | 17 | 29 | 111·7 |
| November .. | ·845 | ·073 | 53·8 | 60·8 | 49·5 | 11·3 | 51·8 | 47·1 | ·372 | 88 | 115·5 | 45·1 | 311 | 4 | N.E. | 10·93 | 15 | 26 | 110·3 |
| December .. | ·822 | ·071 | 53·3 | 60·4 | 48·3 | 12·1 | 49·9 | 44·4 | ·330 | 81 | 107·9 | 42·7 | 293 | 4 | N.E. | 6·19 | 11 | 34 | 129·3 |
| Annual .. | 22·815 | 0·068 | 57·0 | 65·4 | 51·8 | 13·6 | 52·4 | 47·1 | 0·352 | 76 | 122·9 | 45·0 | 307 | 2 | N.N.E. | 67·53 | 119 | 42 | 1894·7 |

## Extreme monthly Meteorological Records at the Kodaikánal Observatory in 1906.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry bulb thermometer. Highest. | | Dry bulb thermometer. Lowest. | | Wet bulb. Lowest. | | Humidity. Lowest. | | Sun Th. *in vacuo.* Highest. | | Grass therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest Fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY. |
| January .. | 22·949 | 20 | 22·774 | 16 | 0·175 | 73·3 | 1 | 41·9 | 13 | 33·9 | 2, 4 | 2 | 4 | 137·3 | 29 | 22 6 | 3 | 686 | 18 | 161 | 2 | 2·83 | 18 |
| February .. | ·960 | 4 | ·761 | 15 | ·199 | 73·1 | 23 | 47·2 | 3 | 35·6 | 8 | 25 | 11 | 141·8 | 13 | 29·7 | 7 | 357 | 1 | 118 | 13 | 2·46 | 28 |
| March .. | ·982 | 10 | ·792 | 19 | ·190 | 74·2 | 26 | 46·9 | 3 | 33·3 | 3 | 14 | 3 | 141·7 | 14 | 34·4 | 11 | 543 | 6 | 172 | 20 | 0·99 | 21 |
| April .. | ·942 | 11 | ·786 | 29 | ·156 | 77·3 | 17 | 50·8 | 1 | 41·4 | 12 | 20 | 16, 25 | 145 0 | 2 | 30·9 | 6 | 480 | 25 | 194 | 4 | 1·82 | 28 |
| May .. | ·907 | 13 | ·753 | 31 | ·154 | 76·1 | 25 | 52·7 | 21 | 42·9 | 31 | 31 | 7, 26 | 142·2 | 13 | 39·3 | 6 | 440 | 9 | 129 | 28 | 1·25 | 1 |
| June .. | ·865 | 10 | ·662 | 17 | ·203 | 74·6 | 1 | 50·7 | 16 | 44·7 | 1 | 36 | 1 | 145·6 | 12 | 39·2 | 1 | 732 | 16 | 126 | 9 | 0·44 | 18 |
| July .. | ·852 | 31 | ·617 | 19 | ·235 | 69·2 | 4 | 50·6 | 21 | 44·1 | 2 | 50 | 2 | 143·6 | 4 | 44·3 | 27 | 735 | 20 | 179 | 9 | 1·26 | 11 |
| August .. | ·883 | 5 | ·661 | 22 | ·222 | 67·1 | 16 | 50·3 | 14 | 42·5 | 13 | 70 | 13 | 140·4 | 11 | 42·5 | 13 | 701 | 23 | 145 | 13 | 1·27 | 18 |
| September .. | ·874 | 15 | ·703 | 5 | ·171 | 67·1 | 30 | 47·6 | 29 | 41·5 | 27 | 32 | 27 | 141 2 | 30 | 37·2 | 7 | 646 | 25 | 85 | 7 | 0·98 | 15 |
| October .. | ·910 | 12 | ·690 | 27 | ·220 | 67·2 | 10 | 47·1 | 31 | 38·9 | 31 | 52 | 30 | 144·0 | 10 | 38·3 | 31 | 679 | 28 | 136 | 11 | 1·25 | 24 |
| November .. | ·918 | 5,27 | ·788 | 19 | ·130 | 65·5 | 17 | 45·8 | 22 | 38·4 | 19 | 39 | 18 | 126·8 | 19 | 37·2 | 26 | 609 | 23 | 142 | 15 | 2·91 | 15 |
| December .. | ·901 | 10 | ·739 | 20 | ·162 | 67·8 | 4 | 43·6 | 12 | 34·2 | 3 | 12 | 14 | 135·2 | 16 | 30·6 | 4 | 548 | 26 | 93 | 30 | 1·25 | 7 |

# Appendix III.

KODAIKÁNAL mean hourly Wind Velocity for the year 1906.

| Month. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hours. | | | | | | | | | | | | | | | | | | | | | | | |
| January .. .. .. .. | 14 | 15 | 15 | 14 | 15 | 14 | 14 | 13 | 13 | 14 | 16 | 14 | 12 | 12 | 11 | 10 | 9 | 8 | 9 | 11 | 12 | 12 | 13 | 14 |
| February .. .. .. | 10 | 9 | 8 | 8 | 8 | 9 | 9 | 8 | 8 | 9 | 10 | 10 | 11 | 10 | 10 | 9 | 8 | 8 | 8 | 10 | 11 | 10 | 10 | 10 |
| March .. .. .. .. | 11 | 12 | 11 | 12 | 13 | 14 | 14 | 14 | 15 | 14 | 16 | 15 | 13 | 12 | 12 | 11 | 10 | 8 | 9 | 9 | 9 | 10 | 10 | 11 |
| April .. .. .. .. | 11 | 11 | 11 | 11 | 12 | 13 | 13 | 14 | 15 | 15 | 16 | 15 | 13 | 11 | 12 | 11 | 10 | 10 | 11 | 13 | 12 | 11 | 11 | 12 |
| May .. .. .. .. | 12 | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 12 | 13 | 13 | 13 | 13 | 13 | 12 | 12 | 11 | 10 | 10 | 11 | 11 | 12 | 12 |
| June .. .. .. .. | 16 | 16 | 16 | 16 | 15 | 15 | 16 | 15 | 14 | 14 | 15 | 14 | 13 | 13 | 14 | 15 | 13 | 14 | 14 | 16 | 16 | 16 | 15 | 16 |
| July .. .. .. .. | 20 | 19 | 19 | 19 | 20 | 19 | 19 | 17 | 17 | 15 | 15 | 14 | 14 | 13 | 14 | 14 | 14 | 16 | 16 | 17 | 17 | 18 | 19 | 20 |
| August .. .. .. .. | 13 | 13 | 14 | 14 | 13 | 12 | 12 | 12 | 13 | 13 | 11 | 12 | 12 | 12 | 12 | 12 | 11 | 12 | 12 | 13 | 14 | 15 | 16 | 16 |
| September .. .. .. | 16 | 17 | 17 | 17 | 16 | 16 | 16 | 16 | 16 | 16 | 14 | 13 | 14 | 12 | 12 | 12 | 10 | 11 | 11 | 12 | 13 | 14 | 15 | 15 |
| October .. .. .. .. | 11 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 14 | 13 | 13 | 13 | 12 | 11 | 11 | 10 | 10 | 9 | 10 | 10 | 10 | 10 | 10 | 11 |
| November .. .. .. | 13 | 13 | 13 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 11 | 12 | 11 | 11 | 11 | 10 | 10 | 11 | 13 | 13 | 13 | 14 | 15 |
| December .. .. .. | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 12 | 13 | 12 | 11 | 11 | 10 | 9 | 9 | 10 | 11 | 13 | 13 | 14 | 14 | 14 |
| Mean .. | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 13 | 14 | 13 | 14 | 13 | 12 | 12 | 12 | 11 | 10 | 11 | 11 | 12 | 13 | 13 | 13 | 14 |

# Appendix IV.

KODAIKÁNAL Mean Hourly Bright Sunshine for the year 1906.

| Month. | Hours. | | | | | | | | | | | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6-7 | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | 18-19 | |
| January .. | 0·12 | 0·67 | 0·81 | 0·85 | 0·86 | 0·81 | 0·75 | 0·76 | 0·64 | 0·45 | 0·27 | 0·02 | .. | The total number of hours of bright sunshine was 1,894·7 which is 43·3 per cent. of the possible amount. |
| February .. | ·16 | ·80 | ·90 | ·89 | ·89 | ·84 | ·75 | ·68 | ·52 | ·46 | ·30 | ·04 | .. | |
| March .. | ·11 | ·73 | ·89 | ·94 | ·92 | ·88 | ·85 | ·70 | ·63 | ·53 | ·50 | ·15 | .. | |
| April .. .. | ·02 | ·68 | ·91 | ·94 | ·95 | ·94 | ·78 | ·67 | 59 | ·50 | ·35 | ·11 | .. | |
| May .. .. | ·19 | ·65 | ·81 | ·86 | ·87 | ·87 | ·85 | ·76 | ·64 | ·54 | ·50 | ·13 | .. | |
| June .. .. | ·07 | ·28 | ·37 | ·45 | ·49 | ·50 | ·36 | ·20 | ·14 | ·08 | ·06 | ·03 | .. | |
| July .. .. | ·08 | ·33 | ·44 | ·48 | ·40 | ·37 | ·28 | ·20 | ·21 | ·12 | ·08 | ·05 | 0·01 | |
| August .. | ·08 | ·36 | ·44 | ·40 | ·37 | ·31 | ·26 | ·21 | ·17 | ·17 | ·11 | ·04 | .. | |
| September .. | ·06 | ·60 | ·67 | ·67 | ·63 | ·53 | ·43 | ·34 | ·23 | ·15 | ·12 | ·04 | .. | |
| October .. | ·03 | ·42 | ·54 | ·55 | ·53 | ·39 | ·36 | ·26 | ·17 | ·18 | ·13 | ·03 | .. | |
| November .. | ·01 | ·30 | ·42 | ·47 | ·43 | ·30 | ·43 | ·45 | ·31 | ·23 | ·20 | ·01 | .. | |
| December .. | ·00 | ·30 | ·49 | ·54 | ·52 | ·44 | ·44 | ·42 | ·44 | ·34 | ·22 | ·03 | .. | |
| Mean .. | 0·08 | 0·51 | 0·64 | 0·67 | 0·66 | 0·61 | 0·54 | 0·47 | 0·39 | 0·31 | 0·24 | 0·06 | 0·00 | |

# Appendix V.

NUMBER of days in each month on which the Nilgiris were visible in 1906.

| Month. | Very clear. | Visible. | Just visible. | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January .. .. .. .. | 2 | 9 | 10 | .. | 21 |
| February .. .. .. .. | .. | 5 | 14 | .. | 19 |
| March .. .. .. .. | 3 | 5 | 6 | 3 | 17 |
| April .. .. .. .. | .. | 1 | 4 | .. | 5 |
| May .. .. .. .. .. | 4 | 6 | 4 | .. | 14 |
| June .. .. .. .. .. | 9 | 3 | 3 | .. | 15 |
| July .. .. .. .. .. | 7 | 3 | 3 | 1 | 14 |
| August .. .. .. .. | 8 | 7 | 3 | .. | 18 |
| September .. .. .. .. | 6 | 9 | 5 | .. | 20 |
| October .. .. .. .. | 6 | 6 | 4 | .. | 16 |
| November .. .. .. .. | 2 | 4 | 2 | 2 | 10 |
| December .. .. .. .. | 8 | 5 | .. | 1 | 14 |
| Total .. | 55 | 63 | 58 | 7 | 183 |

# Appendix VI.

Latitude—10° 9′ N.

Longitude—5*h*. 10*m*. 10*s*. E.

Height of Barometer cistern above sea level 944 ft.

## Mean monthly and annual Meteorological Results at the Periyakulam Observatory in 1906.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer. Mean. | Dry bulb thermometer. Max. | Dry bulb thermometer. Min. | Dry bulb thermometer. Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. By Blanford's tables. | Relative humidity. By Blanford's tables. | Sun Max. *in vac* | Min. on grass. | Wind. Daily velocity. | Wind. Mean direction. | Wind. Mean direction. | Rain. Amount. | Rain. Days. | Clear sky. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | POINTS. | POINTS. | INCHES. | NO. | CENTS. |
| January .. .. .. | 29·007 | 0·146 | 77·4 | 89·2 | 66 9 | 22·3 | 68·8 | 64·6 | 0 590 | 62 | 141·3 | 61·0 | 44·4 | 13 | S.E. by S | 1·95 | 1 | 64 |
| February .. .. .. | 28·958 | ·160 | 81·2 | 93·7 | 70·1 | 23·6 | 70·4 | 65·9 | ·601 | 56 | 147·8 | 64·1 | 50·9 | 13 | S.E. by S. | 1·55 | 1 | 72 |
| March .. .. .. | 29·077 | ·158 | 81·3 | 94·1 | 69·4 | 24·7 | 70·3 | 66·0 | ·596 | 56 | 148 3 | 63·2 | 50·1 | 11 | S.E by E. | 4·15 | 6 | 76 |
| April .. .. .. | 28·891 | ·148 | 86·4 | 101·4 | 73·3 | 28·1 | 72·3 | 68·3 | ·608 | 49 | 157 0 | 66·8 | 56·9 | 11 | S.E. by E. | 0·18 | 1 | 74 |
| May .. .. .. | ·846 | ·134 | 83·9 | 97·1 | 73·5 | 23·6 | 74·7 | 70·9 | ·737 | 63 | 154·1 | 69·7 | 73 3 | 16 | S. | 8·21 | 11 | 61 |
| June .. .. .. | ·822 | ·111 | 82·9 | 95·0 | 73·7 | 21·3 | 72·0 | 68·9 | ·640 | 57 | 154·2 | 69·2 | 102·6 | 16 | S | 0·10 | .. | 36 |
| July .. .. .. | ·803 | ·104 | 81·4 | 94 0 | 72·6 | 21·4 | 71·4 | 68·5 | ·634 | 59 | 154·7 | 68·8 | 89·5 | 18 | S.S.W. | 0·81 | 3 | 39 |
| August .. .. .. | ·845 | ·121 | 79·6 | 90·8 | 71·9 | 18·9 | 72·5 | 69·8 | ·705 | 70 | 148·3 | 68·7 | 51·8 | 13 | S.E. by S. | 10 82 | 10 | 39 |
| September .. .. .. | ·869 | ·133 | 80·1 | 92·0 | 70·7 | 21·3 | 71·0 | 68·0 | ·639 | 62 | 150 0 | 66·1 | 67·8 | 16 | S. | 1·11 | 3 | 45 |
| October .. .. .. | ·916 | ·131 | 78·3 | 88·6 | 71·3 | 17·2 | 72·5 | 69·5 | ·726 | 75 | 136·6 | 67·5 | 37·7 | 15 | S. by E. | 5·16 | 11 | 37 |
| November .. .. .. | ·989 | 123 | 76·2 | 85·5 | 69·9 | 15·6 | 71·2 | 68·0 | ·698 | 77 | 137·3 | 66·1 | 41·1 | 16 | S. | 6·50 | 12 | 37 |
| December .. .. .. | ·970 | ·121 | 75·1 | 85·0 | 67·8 | 17·2 | 69·5 | 66·0 | ·648 | 74 | 131·4 | 63·5 | 32·3 | 10 | E.S.E. | 2 76 | 5 | 39 |
| Annual .. | 28·916 | 0·132 | 80·3 | 92·2 | 70·9 | 21·3 | 71·4 | 68·0 | 0·652 | 63 | 146·8 | 66·2 | 58·4 | 14 | S.S.E. | 43·30 | 64 | 52 |

## Extreme monthly Meteorological Records at the Periyakulam Observatory in 1906.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry bulb thermometer. Highest. | | Dry bulb thermometer. Lowest. | | Wet bulb. Lowest. | | Humidity. Lowest. | | Sun. Th. *in vacuo*. Highest. | | Grass therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY. |
| January .. .. | 29·146 | 20 | 28·827 | 16 | 0·319 | 92·7 | 16 | 59 3 | 1 | 57·4 | 1 | 24 | 31 | 153·4 | 15 | 50·8 | 1 | 82 4 | 14 | 27 1 | 3 | 1·95 | 18 |
| February .. .. | ·159 | 4 | ·763 | 24 | ·396 | 100·2 | 24 | 60·9 | 1 | 58·7 | 1 | 25 | 24 | 156·8 | 15 | 52·4 | 1 | 114 0 | 25 | 27·7 | 19 | 0·85 | 28 |
| March .. .. | ·168 | 10 | ·808 | 19 | ·360 | 98·3 | 31 | 61·4 | 10 | 56·3 | 10 | 16 | 8 | 157·1 | 17 | 51 3 | 10 | 82·6 | 17 | 38·1 | 7 | 2·29 | 18 |
| April .. .. | ·018 | 11 | ·760 | 7 | ·258 | 104·2 | 19 | 67·0 | 13 | 60·4 | 13 | 16 | 13 | 162·7 | 21 | 57·6 | 13 | 80·3 | 30 | 40·8 | 27 | 0·11 | 27 |
| May .. .. | 28·987 | 11 | ·699 | 7 | ·288 | 103·3 | 7 | 66·1 | 20 | 65·8 | 20 | 25 | 7 | 162·1 | 3 | 64 8 | 31 | 111·7 | 27 | 27 1 | 3 | 2·80 | 7 |
| June .. .. | ·939 | 10 | ·702 | 7 | ·237 | 100·2 | 10 | 69·5 | 1 | 64·4 | 1 | 34 | 30, 1 | 166·0 | 12 | 61·9 | 1 | 188·4 | 7 | 36·4 | 18 | 0 05 | 14 |
| July .. .. | ·965 | 31 | ·621 | 19 | ·344 | 99 4 | 24 | 67·6 | 2 | 64·0 | 2 | 25 | 24 | 167·2 | 8 | 60·9 | 2 | 176·2 | 11 | 43·8 | 14 | 0·28 | 20 |
| August .. .. | ·991 | 5 | ·726 | 22 | ·265 | 96·3 | 6 | 68·1 | 31 | 65·3 | 30 | 39 | 30, 31 | 162·8 | 3 | 62·2 | 31 | 96·7 | 4 | 20 9 | 24 | 5·70 | 11 |
| September .. .. | ·998 | 30 | ·739 | 3 | ·259 | 96·3 | 11 | 64·9 | 27 | 62·0 | 27 | 34 | 30 | 160·3 | 8 | 58·2 | 27 | 104·8 | 27 | 26·1 | 21 | 0·72 | 17 |
| October .. .. | 29·038 | 8 | ·758 | 28, 29 | ·280 | 96·1 | 2 | 66·2 | 31 | 63·8 | 31 | 40 | 1 | 158·9 | 3 | 60·0 | 31 | 69·2 | 16 | 4·9 | 26 | 1·13 | 9 |
| November .. .. | ·101 | 27 | ·876 | 10 | ·225 | 91·9 | 4 | 64·6 | 26 | 63·2 | 19, 26 | 42 | 2 | 147·1 | 3, 9 | 59·9 | 26 | 71·2 | 24 | 11.7 | 2 | 2·03 | 8 |
| December .. .. | ·087 | 10 | ·836 | 20 | ·251 | 89·7 | 19 | 59·8 | 13 | 58·4 | 13 | 37 | 24 | 144·4 | 20 | 53·2 | 13 | 65·7 | 24 | 2·6 | 27 | 1·05 | 29 |

# Appendix VII.

MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1906.

| Abnormals of | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November | December. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure .. .. .. | — 0·018 | — 0·049 | + 0·037 | — 0·009 | — 0·013 | Same as | — 0·036 | Same as | — 0·013 | + 0·007 | + 0·031 | — 0·016 | — 0·009 |
| Temperature of air .. .. .. .. .. | + 1·4 | + 3·0 | + 0·2 | + 1·2 | + 2·7 | + 0·5 | + 1·3 | + 0·2 | + 0·6 | + 1·2 | + 0·8 | + 0·5 | + 1·1 |
| Do. of evaporation .. .. .. | + 2·9 | + 3·7 | + 0·9 | + 2·3 | + 3·2 | + 2·4 | + 2·8 | + 2·5 | + 1·9 | + 1·1 | + 1·6 | + 2·2 | + 2·3 |
| Percentage of humidity .. .. .. .. | + 7 | + 4 | + 3 | + 4 | + 4 | + 7 | + 7 | + 10 | + 6 | + 1 | + 4 | + 8 | + 5 |
| Greatest solar heat *in vacuo* .. .. .. .. | — 8·2 | — 3·5 | — 4·8 | — 1·0 | — 1·0 | — 6·2 | — 4·9 | — 5·8 | — 8·4 | — 3·6 | — 4·6 | — 13·5 | — 5·5 |
| Maximum in shade .. .. .. .. .. | — 0·7 | + 1·3 | — 0·7 | + 1·9 | + 3·0 | — 1·0 | + 1·5 | — 1·7 | — 0·3 | + 0·7 | + 0·7 | — 2·0 | + 0·2 |
| Minimum in shade .. .. .. .. .. | + 2·0 | + 4·6 | — 0·5 | + 0·9 | + 2·2 | + 0·5 | + 0·6 | Same as | + 0·4 | + 0·6 | + 0·2 | + 1·6 | + 1·1 |
| Do. on grass .. .. .. .. .. | + 2·9 | + 5·8 | — 0·3 | + 1·3 | + 2·6 | + 0·7 | + 1·5 | + 0·4 | + 0·8 | + 0·4 | + 1·0 | + 2·8 | + 1·8 |
| Rainfall in inches .. .. .. .. .. | + 3·16 | + 0·66 | — 0·39 | — 0·62 | — 2·12 | + 0·29 | + 0·58 | — 0·11 | — 1·58 | — 6·85 | — 6·74 | + 11·15 | .... |
| Do. since January .. .. .. .. | .. | + 3·82 | + 3·43 | + 2·81 | + 0·69 | + 0·98 | + 1·56 | + 1·45 | + 3·03 | — 3·82 | — 10·56 | + 0·59 | + 0·59 |
| General direction of wind .. .. .. .. | 3 points E. | 4 points S | 1 point E. | 1 point S. | 1 point S. | 1 point S. | Same as | Same as | 2 points W. | 3 points S. | 2 points E. | 2 points F. | 1 point S. |
| Daily velocity in miles .. .. .. .. | — 17 | + 14 | — 19 | + 19 | — 3 | — 24 | — 5 | — 40 | — 26 | — 13 | — 22 | + 8 | — 10 |
| Percentage of cloudy sky .. .. .. .. | + 11 | + 8 | — 1 | — 9 | — 9 | Same as | — 9 | — 15 | — 3 | — 12 | Same as | + 11 | — 3 |
| Do. of bright sunshine .. .. .. | — 22·4 | — 13·1 | — 12·1 | — 11·6 | — 12·9 | — 19·1 | + 0·8 | + 0·6 | — 8·6 | — 1·0 | — 13·9 | — 21·7 | — 11·2 |

+ means *above* normal, — *below*.

# Appendix VIII.

ABSTRACT of the mean meteorological condition of Madras in the year 1906 compared with the average of past years.

| Mean values of | 1906. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure .. .. .. .. .. .. | 29·855 | 0·009 below. | 29·864 |
| Temperature of air .. .. .. .. .. .. .. | 82·2 | 1·1 above. | 81·1 |
| Do. of evaporation .. .. .. .. .. .. | 76·8 | 2 3 ,, | 74·5 |
| Percentage of humidity .. .. .. .. .. .. | 77 | 5 ,, | 72 |
| Greatest solar heat *in vacuo* .. .. .. .. .. .. | 134·2 | 5·5 below. | 139·7 |
| Maximum in shade .. .. .. .. .. .. .. | 91·0 | 0·2 above. | 90·8 |
| Minimum in shade .. .. .. .. .. .. .. | 75·8 | 1·1 ,, | 74 7 |
| Do. on grass .. .. .. .. .. .. .. | 73·7 | 1·8 ,, | 71 9 |
| Rainfall since January 1st on 92 days .. .. .. .. | 49·61 | 0 59 ,, | 49·02 |
| General direction of wind .. .. .. .. .. .. | S.E. by S. | 1 point S. | S.E. |
| Daily velocity in miles .. .. .. .. .. .. .. | 161 | 10 below. | 171 |
| Percentage of cloudy sky .. .. .. .. .. .. | 46 | 3 ,, | 49 |
| Do. of bright sunshine .. .. .. .. .. .. | 47·2 | 11 2 ,, | 58·4 |

DURATION and quantity of the wind from different points.

| From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North .. | 170 | 1,285 | East .. | 174 | 810 | South .. | 168 | 1,194 | West .. | 199 | 1,615 |
| N. by E. .. | 269 | 1,945 | E. by S. .. | 315 | 1,640 | S. by W... | 311 | 2,091 | W. by N... | 250 | 1,849 |
| N.N.E. .. | 214 | 1,349 | E.S.E. .. | 338 | 1,617 | S.S.W. .. | 228 | 1,620 | W.N.W. .. | 157 | 1,203 |
| N.E. by N... | 230 | 1,632 | S.E. by E. | 712 | 3,929 | S.W. by S. | 244 | 1,559 | N.W. by W. | 158 | 1,100 |
| N.E. .. | 153 | 1,345 | S.E. .. | 504 | 3,023 | S.W. .. | 137 | 845 | N.W. .. | 58 | 418 |
| N E. by E. | 219 | 1,717 | S.E. by S. | 1,140 | 9,466 | S.W. by W. | 266 | 1,751 | N.W. by N. | 83 | 493 |
| E.N.E. .. | 155 | 836 | S S.E. .. | 398 | 2,963 | W.S.W. .. | 212 | 1,533 | N.N.W. .. | 81 | 493 |
| E. by N. .. | 184 | 990 | S. by E. .. | 334 | 2,431 | W. by S... | 336 | 2,376 | N. by W... | 231 | 1,490 |

There were 132 calm hours during the year. The resultant corresponding to the above numbers is represented by a S.E. by S. wind, blowing with a uniform daily velocity of 48 miles.

# Appendix IX.

MADRAS OBSERVATORY.—Number of hours of wind from each point in the year 1906.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. .. .. | 10 | 23 | 33 | 49 | 38 | 50 | 60 | 36 | 74 | 121 | 80 | 57 | 33 | 12 | 1 | . | 2 | 2 | 3 | 2 | 4 | 3 | .. | 1 | . | .. | .. | .. | . | .. | 4 | 21 | 25 |
| February .. .. .. .. | 1 | . | .. | 5 | 3 | 4 | 7 | 13 | 30 | 60 | 76 | 148 | 58 | 151 | 21 | 23 | 5 | 12 | 15 | 11 | 5 | 7 | 6 | 2 | . | . | 1 | .. | 1 | . | .. | .. | 7 |
| March .. .. .. .. | 3 | 2 | 4 | 2 | 4 | 17 | 27 | 27 | 24 | 55 | 50 | 152 | 129 | 123 | 41 | 10 | 12 | 12 | 14 | 5 | 1 | 4 | 1 | . | 1 | . | .. | .. | .. | 1 | . | 3 | 20 |
| April .. .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 33 | 341 | 128 | 52 | 29 | 55 | 43 | 25 | 8 | 1 | . | . | .. | . | .. | .. | .. | .. | .. | .. | 5 |
| May .. .. .. .. | .. | 2 | 1 | .. | .. | 1 | .. | 1 | 2 | 3 | 11 | 15 | 42 | 190 | 90 | 96 | 42 | 70 | 49 | 30 | 4 | 10 | 11 | 16 | 14 | 15 | 10 | 8 | 6 | 1 | 1 | .. | 3 |
| June .. .. .. .. | 1 | .. | 1 | .. | 2 | .. | 1 | 3 | 3 | 5 | 8 | 38 | 32 | 86 | 39 | 60 | 17 | 37 | 18 | 32 | 23 | 49 | 41 | 77 | 36 | 34 | 35 | 22 | 5 | 7 | 4 | .. | 4 |
| July .. .. .. .. | .. | 3 | 1 | .. | 1 | .. | 1 | 2 | 3 | 5 | 5 | 20 | 14 | 52 | 23 | 37 | 16 | 35 | 17 | 36 | 33 | 85 | 68 | 103 | 56 | 68 | 13 | 26 | 6 | 7 | 4 | 3 | 1 |
| August .. .. .. .. | 3 | 10 | 5 | 2 | 2 | 1 | 3 | 12 | 7 | 23 | 30 | 49 | 33 | 48 | 16 | 20 | 5 | 37 | 24 | 49 | 38 | 60 | 41 | 50 | 30 | 44 | 26 | 33 | 7 | 17 | 5 | 1 | 13 |
| September .. .. .. .. | .. | 1 | .. | 1 | 1 | 1 | 3 | 1 | 2 | 8 | 20 | 41 | 40 | 34 | 24 | 7 | 14 | 22 | 34 | 25 | 17 | 25 | 38 | 70 | 55 | 72 | 65 | 54 | 12 | 7 | 1 | 3 | 22 |
| October .. .. .. .. | 30 | 48 | 14 | 22 | 11 | 17 | 13 | 38 | 8 | 10 | 33 | 121 | 49 | 54 | 10 | 15 | 3 | 20 | 8 | 22 | 3 | 21 | 6 | 15 | 6 | 17 | 6 | 14 | 21 | 16 | 16 | 37 | 20 |
| November .. .. .. .. | 32 | 86 | 71 | 75 | 62 | 86 | 27 | 18 | 14 | 8 | 3 | 20 | 17 | 23 | 4 | 2 | 17 | 6 | 3 | 5 | 1 | 1 | .. | 2 | 1 | . | 1 | 1 | .. | 15 | 30 | 83 | 6 |
| December .. .. .. .. | 90 | 94 | 84 | 74 | 29 | 42 | 13 | 33 | 7 | 17 | 22 | 51 | 24 | 26 | 1 | 12 | 6 | 3 | .. | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 12 | 16 | 80 | 6 |
| Annual .. | 170 | 269 | 214 | 230 | 153 | 219 | 156 | 184 | 174 | 315 | 338 | 712 | 504 | 1,140 | 398 | 334 | 168 | 311 | 228 | 244 | 137 | 266 | 212 | 336 | 199 | 250 | 157 | 158 | 58 | 83 | 81 | 231 | 132 |

# Appendix X.

Madras Observatory.—Number of miles of wind from each point in the year 1906.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. .. .. | 77 | 191 | 228 | 325 | 372 | 370 | 268 | 222 | 230 | 578 | 343 | 311 | 95 | 79 | 2 | .. | 12 | 5 | 10 | 9 | 12 | 9 | .. | 3 | .. | .. | .. | .. | .. | . | 27 | 160 | 3938 |
| February .. .. .. .. | 8 | . | .. | 54 | 31 | 36 | 47 | 92 | 124 | 261 | 265 | 728 | 404 | 1076 | 150 | 87 | 26 | 89 | 99 | 79 | 35 | 50 | 32 | 10 | .. | .. | 7 | .. | 5 | .. | .. | .. | 3795 |
| March .. .. . . | 12 | 5 | 7 | 3 | 22 | 100 | 116 | 111 | 131 | 290 | 246 | 917 | 675 | 911 | 184 | 78 | 82 | 81 | 98 | 24 | 2 | 16 | 2 | .. | 2 | .. | .. | .. | .. | 5 | .. | 11 | 4131 |
| April .. . .. . . | .. | | | .. | | | | .. | .. | .. | .. | .. | 296 | 2957 | 1140 | 447 | 274 | 539 | 378 | 199 | 44 | 14 | .. | .. | .. | .. | .. | | | . | .. | . | 6288 |
| May .. .. .. .. | .. | 17 | 10 | .. | .. | 8 | . | 11 | 16 | 32 | 110 | 145 | 405 | 2096 | 763 | 865 | 349 | 545 | 433 | 235 | 26 | 77 | 88 | 141 | 128 | 182 | 115 | 76 | 53 | 7 | 1 | .. | 6934 |
| June .. .. .. . . | 10 | .. | 7 | .. | 18 | .. | 10 | 31 | 23 | 31 | 58 | 312 | 270 | 877 | 304 | 379 | 127 | 198 | 113 | 212 | 153 | 359 | 360 | 681 | 362 | 312 | 336 | 230 | 34 | 38 | 29 | . | 5874 |
| July .. .. .. .. .. | .. | 23 | 9 | .. | 12 | .. | 9 | 18 | 30 | 42 | 53 | 179 | 124 | 458 | 161 | 292 | 123 | 211 | 115 | 244 | 229 | 648 | 615 | 848 | 507 | 564 | 130 | 207 | 39 | 37 | 31 | 20 | 5978 |
| August .. .. .. . | 21 | 23 | 24 | 15 | 15 | 7 | 19 | 66 | 41 | 162 | 186 | 276 | 170 | 237 | 82 | 102 | 35 | 161 | 157 | 308 | 257 | 367 | 219 | 276 | 224 | 282 | 120 | 178 | 41 | 61 | 13 | 6 | 4151 |
| September .. .. .. .. | .. | 7 | .. | 5 | 7 | 7 | 20 | 6 | 14 | 60 | 115 | 234 | 192 | 198 | 98 | 39 | 67 | 104 | 151 | 128 | 63 | 111 | 193 | 334 | 356 | 441 | 454 | 325 | 109 | 26 | 4 | 21 | 3889 |
| October .. .. .. . | 184 | 242 | 38 | 96 | 71 | 104 | 76 | 146 | 46 | 41 | 118 | 487 | 201 | 307 | 43 | 60 | 16 | 103 | 51 | 79 | 17 | 96 | 24 | 77 | 33 | 68 | 39 | 79 | 137 | 99 | 78 | 160 | 3416 |
| November .. .. .. .. | 198 | 471 | 379 | 514 | 512 | 766 | 155 | 102 | 86 | 53 | 13 | 82 | 57 | 87 | 29 | 8 | 47 | 19 | 15 | 26 | 7 | 4 | .. | 6 | 3 | .. | 2 | 5 | .. | 81 | 147 | 427 | 4301 |
| December .. . .. .. | 775 | 966 | 647 | 620 | 285 | 319 | 116 | 185 | 69 | 90 | 110 | 258 | 134 | 183 | 7 | 74 | 36 | 36 | .. | 16 | .. | . | .. | .. | .. | .. | .. | .. | .. | 139 | 163 | 685 | 5913 |
| Annual .. | 1285 | 1945 | 1349 | 1632 | 1345 | 1717 | 836 | 990 | 810 | 1640 | 1617 | 3929 | 3023 | 9466 | 2963 | 2431 | 1194 | 2091 | 1620 | 1559 | 845 | 1751 | 1533 | 2376 | 1615 | 1849 | 1203 | 1100 | 418 | 493 | 493 | 1490 | 58608 |

# Appendix XI.

Madras Observatory.—Number of inches of rain from each point in the year 1906.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. .. | .. | 0·45 | 0·79 | 0·75 | 0·35 | 0·92 | 0·08 | 0·16 | 0·12 | 0·12 | 0·10 | 0·09 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·12 | .. |
| February .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·56 | 0·32 | .. | 0·01 | .. | 0·05 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| March .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| April .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| May .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| June .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·08 | 0·01 | .. | 0·01 | .. | 0·01 | .. | 0·85 | 0·02 | 0·50 | 0·05 | 0·02 | 0·17 | 0·03 | 0·27 | .. | .. | 0·31 | 0·07 | .. | .. |
| July .. .. .. | .. | .. | .. | .. | .. | .. | .. | 0·03 | .. | .. | .. | 0·03 | 0·24 | 0·02 | .. | 0·11 | .. | 0·32 | .. | 0·42 | .. | 0·60 | 0·99 | 0·29 | .. | 0·45 | 0·02 | 0·06 | .. | .. | 0·04 | 0·83 | .. |
| August .. .. .. | .. | .. | .. | .. | .. | .. | .. | 0·01 | 0·05 | 0·04 | 0·04 | .. | .. | 0·07 | .. | 0·05 | 0·01 | 0·03 | 0·98 | 0·58 | 0·37 | 0·19 | 0·05 | 0·04 | 1·65 | 0·11 | .. | 0·11 | .. | 0·07 | .. | .. | .. |
| September .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·01 | 1·43 | .. | 0·25 | .. | 0·01 | .. | .. | 0·18 | 0·03 | 0·17 | 0·20 | 1·55 | 0·32 | 0·16 | 0·42 | 0·82 | 0·24 | .. | 0·40 | .. | 0·06 | 0·02 |
| October .. .. .. | 0·67 | 0·69 | 0·66 | 0·08 | 0·02 | 0·34 | .. | 0·34 | 0·01 | 0·33 | 0·37 | .. | 0·37 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·08 | .. | .. | 0·13 | .. | .. | 0·06 | .. |
| November .. .. | 0·03 | 0·46 | 0·78 | 0·17 | 0·43 | 0·26 | 0·59 | 0·07 | 0·11 | 0·63 | 0·11 | 0·43 | .. | .. | .. | .. | .. | .. | .. | 0·19 | .. | .. | .. | 0·82 | .. | .. | .. | .. | .. | 0·27 | 0·83 | 0·29 | .. |
| December .. .. | 2·96 | 2·43 | 0·33 | 1·76 | 0·64 | 1·27 | 0·16 | 1·47 | 0·29 | .. | 0·57 | 0·13 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·56 | 0·58 | 3·28 | .. |
| Annual .. | 3·66 | 4·03 | 2·56 | 2·76 | 1·44 | 2·79 | 0·83 | 2·08 | 1·14 | 1·44 | 1·20 | 2·12 | 0·69 | 0·40 | .. | 0·18 | 0·01 | 0·36 | 1·16 | 2·07 | 0·56 | 1·49 | 2·64 | 1·49 | 1·98 | 1·09 | 1·11 | 0·41 | 0·13 | 1·61 | 1·52 | 4·64 | 0·02 |

# Appendix XII.

Madras Observatory.—Wind, cloud and bright sunshine, 1906.

| Month. | Wind resultant. | | Clouds (0—10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H. | 16 H. | 20 H. | Mean. | Average per day. | Greatest number of hours in a day. |
| | MILES. | | | | | | | HOURS. | |
| January .. .. .. .. | 94 | E.N.E. | 4·6 | 5·5 | 5·1 | 3·6 | 4·8 | 5·9 | 8·9 |
| February .. .. .. | 110 | S.E. | 3·6 | 4·4 | 3·0 | 1·6 | 3·2 | 8·1 | 10·0 |
| March .. .. .. .. | 113 | S.E. | 2·2 | 3·3 | 2·1 | 1·5 | 2·3 | 8 0 | 10·3 |
| April .. .. .. .. | 195 | S.S.E. | 3·4 | 2·1 | 1·4 | 0·7 | 1·9 | 8·0 | 9·4 |
| May .. .. .. .. | 165 | S. by E. | 3·5 | 3·2 | 2·7 | 2·0 | 2·9 | 6·9 | 9 2 |
| June .. .. .. .. | 98 | S.W. by S. | 6·1 | 6·3 | 7·4 | 6·0 | 6·4 | 3·5 | 7·3 |
| July .. .. .. .. | 118 | S.W. by W. | 6·5 | 5·8 | 6·6 | 6·0 | 6·2 | 4·2 | 7·6 |
| August .. .. .. .. | 58 | S.W. by S. | 5 1 | 5·3 | 6·4 | 4·1 | 5·2 | 5·2 | 9·6 |
| September .. .. .. | 60 | W.S.W. | 6·5 | 5·8 | 6·1 | 4·9 | 5·9 | 8·6 | 9·7 |
| October .. .. .. .. | 23 | E. | 4·7 | 5·3 | 4·8 | 3·8 | 4·7 | 6·0 | 10·3 |
| November .. .. .. | 107 | N.E. by N. | 5·5 | 7·0 | 6·5 | 4·6 | 5 9 | 4·4 | 9·3 |
| December .. .. .. | 129 | N.N.E. | 6·2 | 6·6 | 7·2 | 5·2 | 6·3 | 4·0 | 8·3 |
| Annual .. | 48 | S.E. by S. | 4·8 | 5·1 | 4·9 | 3·7 | 4·6 | 6·1 | 9·2 |

# Appendix XIII.

MEAN monthly and annual Meteorological results at the Madras Observatory in 1906.

| | Barometer. | | Dry bulb thermometer. | | | | Wet bulb. | | Tension of vapour. | Relative humidity. | Sun Max. *in vac.* | Min. on grass. | Wind. | | | Rain. | | Cloudy sky. | Bright sun-shine. | Dew point. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reduced to 32°. | Daily range. | Mean. | Max. | Min. | Range. | Mean. | Min. | By Blanford's tables. | | | | Daily velo-city. | Mean direction. | | Amount | Days. | | | |
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | PTS. | POINTS. | INCHES. | NO. | CENTS. | HOURS | ° |
| January .. .. .. | 29·979 | 0·103 | 76·5 | 83·9 | 69·5 | 14·4 | 72·1 | 68·6 | 0·733 | 80 | 130·2 | 66·6 | 127 | 8 | E. | 4·05 | 5 | 48 | 182·3 | 69·0 |
| February .. .. .. | ·916 | ·130 | 79·7 | 87·9 | 72·6 | 15·3 | 74·5 | 71·6 | ·789 | 77 | 136·2 | 69·6 | 136 | 12 | S. E. | 0·94 | 3 | 32 | 226·0 | 71·0 |
| March .. .. .. | ·942 | ·122 | 80·2 | 88·5 | 71·6 | 16·9 | 74·8 | 70·7 | ·792 | 77 | 135·7 | 68·3 | 133 | 11 | S. E. by E. | .. | .. | 23 | 248·4 | 70·9 |
| April .. .. .. | 817 | ·132 | 85·2 | 94·8 | 78·1 | 16·7 | 79·9 | 76·8 | ·951 | 78 | 140·7 | 76·0 | 210 | 14 | S. S. E. | .. | .. | 19 | 239·7 | 76·4 |
| May .. .. .. | ·722 | ·124 | 89·4 | 100·8 | 83·0 | 17·8 | 81·5 | 77·8 | ·971 | 71 | 142·0 | 81·5 | 224 | 16 | S. | .. | .. | 29 | 214·1 | 76·5 |
| June .. .. .. | ·703 | ·121 | 86·9 | 97·3 | 80·8 | 16·5 | 79·0 | 75·8 | ·886 | 69 | 134·3 | 79·3 | 196 | 18 | S. S. W. | 2·40 | 6 | 64 | 105·7 | 73·9 |
| July .. .. .. | ·685 | ·113 | 85·8 | 97·1 | 79·1 | 18·0 | 78·7 | 74·9 | ·887 | 72 | 133·8 | 78·1 | 193 | 20 | S. W. | 4·45 | 15 | 62 | 131·5 | 74·1 |
| August .. .. .. | ·749 | ·128 | 83·5 | 92·0 | 77·3 | 14·7 | 78·5 | 75·2 | ·911 | 80 | 134·2 | 75·8 | 134 | 19 | S. W. by S. | 4·45 | 12 | 52 | 161·0 | 75·2 |
| September .. .. .. | ·764 | 122 | 83·6 | 92·9 | 77·5 | 15·4 | 78·2 | 74·9 | ·892 | 78 | 132·9 | 75·8 | 130 | 20 | S. W. | 6·27 | 14 | 59 | 129·7 | 74·6 |
| October .. .. .. | ·818 | ·129 | 81·8 | 89·7 | 75·8 | 13·9 | 76·7 | 74·1 | ·857 | 79 | 135·5 | 73·2 | 110 | 10 | E. S. E. | 4·15 | 9 | 47 | 186·5 | 73·3 |
| November .. .. .. | ·954 | ·107 | 78·3 | 85·7 | 72·5 | 13·2 | 74·5 | 71·5 | ·803 | 83 | 132·8 | 70·5 | 143 | 4 | N. E. | 6·47 | 15 | 59 | 131·1 | 71·9 |
| December .. .. .. | ·933 | ·108 | 76·0 | 81·6 | 71·4 | 10·2 | 72·8 | 70·2 | ·768 | 85 | 122·3 | 69·2 | 191 | 4 | N. E. | 16·43 | 13 | 63 | 124·3 | 70·5 |
| Annual .. | 29·834 | 0·120 | 82·2 | 91·0 | 75·8 | 15·2 | 76·8 | 73·5 | 0·853 | 77 | 134·2 | 73·7 | 161 | 13 | S. E. by S. | 49·61 | 92 | 46 | 2,080·3 | 73·1 |

EXTREME monthly Meteorological records at the Madras Observatory in 1906.

| | Barometer. | | | | | Dry bulb thermometer. | | | | Wet bulb. | | Humidity. | | Sun Th. *in vacuo.* | | Grass therm. | | Wind. | | | | Rain. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | | Lowest. | | Range. | Highest. | | Lowest. | | Lowest. | | Lowest. | | Highest. | | Lowest. | | Highest. | | Lowest. | | Greatest fall. | |
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES | DAY. |
| January .. .. .. | 30·095 | 20 | 29·850 | 16 | 0·245 | 86·8 | 10 | 65·1 | 1 | 65·0 | 9 | 54 | 9 | 138·2 | 12 | 60·9 | 1 | 284 | 16 | 59 | 2 | 2·38 | 16 |
| February .. .. .. | ·116 | 4 | ·736 | 24 | ·380 | 94·8 | 19, 23 | 64·4 | 3 | 63·6 | 3 | 50 | 5 | 146·3 | 18 | 60·3 | 3 | 204 | 12 | 83 | 3 | 0·77 | 28 |
| March .. .. .. | ·110 | 5 | ·770 | 19 | ·340 | 92·4 | 19 | 67·7 | 3 | 66·7 | 3 | 56 | 22 | 145·1 | 19 | 64·1 | 12 | 201 | 19 | 86 | 5 | .. | .. |
| April .. .. .. | 29·939 | 11 | ·674 | 19 | ·265 | 101·5 | 20 | 71·8 | 12 | 70·4 | 12 | 43 | 12 | 144·5 | 9 | 67·5 | 12 | 328 | 18 | 153 | 1 | .. | .. |
| May .. .. .. | ·905 | 11 | ·547 | 25 | ·358 | 111·5 | 27 | 77·2 | 6 | 74·8 | 18, 19, 21 | 38 | 24 | 149·6 | 18 | 74·6 | 6 | 272 | 29 | 170 | 18 | .. | .. |
| June .. .. .. | ·866 | 10 | ·544 | 20 | ·322 | 106·1 | 2 | 75·8 | 14 | 72·4 | 15 | 41 | 20 | 149·5 | 3 | 74·5 | 14 | 259 | 7 | 95 | 10 | 1·43 | 11 |
| July .. .. .. | ·897 | 31 | ·477 | 19 | ·420 | 103·2 | 2 | 73·0 | 28 | 73·0 | 28 | 45 | 6 | 143·7 | 24 | 72·7 | 17 | 295 | 23 | 126 | 16 | 1·25 | 28 |
| August .. .. .. | ·890 | 5 | ·577 | 24 | ·313 | 97·9 | 30, 31 | 73·5 | 20 | 73·0 | 20 | 43 | 28 | 144·3 | 18 | 72·7 | 20 | 204 | 28 | 56 | 21 | 1·58 | 1 |
| September .. .. .. | ·921 | 15 | ·613 | 5 | ·308 | 99·4 | 13 | 72·3 | 20 | 72·0 | 28 | 45 | 6 | 147·9 | 5 | 72·3 | 20 | 188 | 12 | 56 | 19 | 3·98 | 20 |
| October .. .. .. | ·977 | 12 | ·611 | 28 | ·366 | 94·6 | 12 | 69·2 | 28 | 65·6 | 28 | 33 | 30 | 148·6 | 10 | 67·7 | 28 | 172 | 25 | 83 | 10 | 1·84 | 18 |
| November .. .. .. | 30·070 | 27 | ·833 | 1 | ·237 | 90·9 | 6 | 68·7 | 27 | 67·6 | 27 | 53 | 7 | 143·5 | 9 | 65·6 | 27 | 215 | 24 | 76 | 29 | 1·66 | 23 |
| December .. .. .. | ·073 | 10 | ·772 | 14 | ·301 | 84·9 | 23 | 63·4 | 3 | 63·3 | 3 | 58 | 11 | 135·4 | 16 | 58·0 | 2 | 398 | 26 | 95 | 29 | 3·59 | 13 |

# KODAIKÁNAL AND MADRAS OBSERVATORIES.

## REPORT FOR THE YEAR 1907.

CONTENTS.

# KODAIKÁNAL AND MADRAS OBSERVATORIES.

## I.—REPORT OF THE KODAIKÁNAL OBSERVATORY FOR THE YEAR 1907.

1. **Staff.**—The staff of the Observatory on the 31st December 1907 was as follows:—

| | |
|---|---|
| Director .. .. .. .. | C. Michie Smith, B.Sc. (*on furlough*). |
| Acting Director .. .. . | J. Evershed. |
| Assistant Director .. .. .. | *Vacant.* |
| First Assistant .. .. .. | K. V. Sivarama Aiyar, M.A. |
| Second Assistant .. .. .. | S. Sitarama Aiyar, B.A. |
| Third Assistant .. .. .. | G. Nagaraja Aiyar. |
| Fourth Assistant .. .. .. | S. Balasundaram Aiyar. |
| Writer .. .. .. | L. N. Krishnaswami Aiyar (*on leave*). |
| Acting Writer .. .. .. | K. A. Visvanatha Aiyar. |
| Photographic Assistant .. .. | R. Krishna Aiyar. |

Mr. Evershed joined his appointment on January 21, after a visit to the principal American observatories.

The director was absent on combined privilege leave and furlough for nine months from April 1. The assistant director acted as director during the period. The first assistant was on leave from March 7 to November 4. The second and third assistants acted as first and second assistants respectively, while the post of the third assistant was filled by S. Muthuswami Aiyar, B.A. The writer was on leave from October 3, his place being filled by K. A. Visvanatha Aiyar, the Periyakulam observer.

The subordinate staff of the observatory consists of a book-binder, a book-binder's boy, a mechanic, four peons, a boy peon for the dark room, and two lascars.

2. **Distribution of work.**—The director was in charge of the spectrograph until he went on leave. The assistant director is in charge of the spectroheliograph. The first, second, and third assistants are in charge of the work with the Cooke equatorial (spectroscopic), the Lerebour and Secretan equatorial (visual), the photoheliograph, the transit instrument, and the seismometer. They have also to do the astronomical computing and the preparation of the observations for the press. The fourth assistant has charge of the clock comparisons and, with the help of the writer, is responsible for the whole of the meteorological work. The writer is responsible for the accounts, correspondence, and all office records. The photographic assistant has charge of most of the photographic developing, printing, etc.

3. **Buildings and grounds**—(*a*) *Spectroheliograph building.*—The new moving roof for covering the siderostat was fit for use by the end of January, but the gearing for moving the roof had not been received at the end of the year. A pier for a new spectrograph was constructed in November.

(*b*) *Photoheliograph building.*—The new dome was completed on March 26 and the photoheliograph was moved into it next day. The dome works well and gives satisfaction.

(*c*) *House for the Assistant Director.*—This building was not ready for occupation till December.

(*d*) *Other buildings.*—All the buildings are in good condition.

(*e*) The aeromotor was dismantled for repairs in March and had not been re-erected by the end of the year. All the water required had to be carried by the lascars.

4. **Instruments.**—The following are the principal instruments belonging to the Observatory or in use at the present time:—

Six-inch Cooke equatorial.
Six-inch Lerebour and Secretan equatorial remounted by Grubb with a five-inch Grubb portrait lens of 36 inches focus attached.
Spectrograph I.—consisting of slit, collimator lens of 4 or 7 feet focus, 2-inch parabolic grating, and camera tube without lens. Used in connection with an 11-inch polar siderostat and 6-inch Grubb lens of 40 feet focus.
A rhomb with ends cut at 45°, mounted on a graduated circle, can be placed in front of the slit so as to enable any part of the limb to be brought on to the slit.
Spectrograph II.—consisting of slit, collimator lens of 3 feet focus, 3-inch plane grating and camera lens of 7 feet focus. Used in connection with the 12-inch photo-visual lens of the spectroheliograph.
Spectroheliograph—with 18-inch siderostat and 12-inch Cooke photo-visual lens of 20 feet focus, by the Cambridge Scientific Instrument Company.
An auxiliary spectroheliograph attached to the above, made in the Observatory workshop.
Six-inch transit instrument and barrel chronograph, formerly the property of the Survey of India
Six-prism table spectroscope—Hilger.
Photoheliograph Dallmeyer No. 4.
Theodolite, six-inch—Cooke.
Two phototheodolites by Steinheil, for cloud photography.
Sextant.
Evershed spectroscope with three prisms for prominence and sunspot work, by Hilger.
Mean time clock, Kullberg 6326.
Do. Shelton.
Do. Chronometer 6299.
Sidereal chronometer, Kullberg 6134.
Tape chronograph, Fuess.
Micrometer for measuring spectrum photographs, Hilger.
Dividing engine, Cambridge Scientific Instrument Company, Limited.
Two Balfour Stewart actinometers.
Buchanan's solar calorimeter.
Induction coil with necessary adjuncts.
Small polar siderostat.
Universal instrument.
Complete set of meteorological instruments, including Richard barograph and thermograph, and wind recorders.

A high class screw cutting turning lathe by Messrs Cooke & Sons.

*The Spectroheliograph.*—The new moving roof was ready about the end of January and the spectroheliograph was in constant use from January 31st. In April the new collimator slit referred to in the last report was fitted and the camera slit was modified in several ways to secure greater stability and to afford protection from dust; a device was also added to facilitate setting the slit on any desired position in the spectrum and for automatically recording its exact position after each exposure. The working of the instrument, after these modifications, has been entirely satisfactory.

The auxiliary spectroheliograph is intended for photographing the hydrogen flocculi with high dispersion. It is of the Littrow type with one lens serving for both collimator and camera, and a plane grating. A large direct vision prism and plane mirror can be substituted for the grating the light being twice transmitted through the prism. The collimator slit is placed vertically above and in line with the camera slit, and the whole apparatus is attached to the side of the main spectroheliograph and moves with it. Up to the present time only experimental plates have been taken with this instrument, mostly for purposes of adjustment.

## OBSERVATIONS.

### (a) Solar Physics.

5. The first five months of the year were favourable for solar observations. September and December were also favourable, but the remaining five months were distinctly unfavourable. There were only thirteen days in the year on which no observations were possible. The following table shows for each day the observations that were made.

# Table A.

## Solar Observations in 1907.

A = Spots observed. B = Spot spectra. C = Prominences. D = Photoheliograms. E = Spectroheliograms.

| Date. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 .. | ABCD | ABCDE | ABCDE | A—CDE | A—CDE | A—CDE | A——D— | A——D*E* | A——D*E* | A—CDE | A——— *E* | A—CDE |
| 2 .. | ABCD | ABCDE | ABCDE | A—CD*E* | A—CDE | A—CDE | —— | *A*——D*E* | ABCDE | A——D*E* | A—CDE | A—CDE |
| 3 .. | ABCD | ABCD*E* | ABCDE | ABCD*E* | A—CDE | ABCDE | A—CDE | A—CD*E* | ABCDE | —— | A——D*E* | ABCDE |
| 4 .. | ABCD | ABCDE | ABCDE | ABCDE | A—CDE | ABCDE | A—CDE | A—CDE | ABCDE | A—CDE | —— | A—CDE |
| 5 .. | —— | AB*C*DE | ABCDE | ABCDE | ABCD*E* | A—CDE | ABCDE | A——D*E* | A—CDE | A—CDE | —— | ABCDE |
| 6 .. | A——D | ABCDE | ABCDE | A—CDE | ABCDE | A—CD*E* | A—CDE | A—CD*E* | ABCDE | A——D*E* | —— | A—CDE |
| 7 .. | ABCD | ABCDE | ABCDE | ABCDE | A—CDE | A—*C*DE | A——D*E* | A——D— | A—CDE | A—CDE | A—*C*DE | A—CDE |
| 8 | ABCD | ABCDE | ABCDE | ABCDE | ABCDE | A—CDE | A—CDE | A——D— | A—CDE | A——D*E* | A——— | ABCDE |
| 9 .. | ABCD | ABCDE | ABCDE | ABCDE | A—CDE | A—CDE | A—*C*D*E* | A—CDE | A—CDE | A—CDE | A——D— | ABCDE |
| 10 .. | A——D | ABCDE | ABCDE | ABCDE | A—CDE | A——D*E* | A—CD*E* | A——D*E* | ABCDE | A—CDE | A——D— | ABCDE |
| 11 .. | A——— | ABCDE | ABCDE | A—*C*D*E* | ABCDE | A——— | A—CDE | A——D— | A—*C*DE | ABCDE | A—CDE | ABCDE |
| 12 .. | ABCD | ABCDE | ABCDE | A—CDE | ABCDE | A——— | A—CDE | A——D— | ABCDE | ABCDE | A——D— | A—CDE |
| 13 .. | ABCD | ABCDE | ABCDE | A—CDE | ABCDE | —— | A—CD*E* | A——D*E* | A—CDE | A—CDE | A——D*E* | —— |
| 14 .. | ABCD | ABCDE | ABCDE | A—CDE | A—CDE | A—*C*D*E* | A—CDE | A—*C*D*E* | A—CDE | ABCDE | A——D*E* | A—CDE |
| 15 .. | ABCD | ABCDE | ABCDE | A—CD*E* | A—CDE | A——D— | A—C—E | A——D*E* | A—*C*DE | A—CDE | ABCDE | A—CDE |
| 16 .. | ABCD | ABCDE | ABCDE | A—CD*E* | A—CDE | A—CDE | A—CDE | A—CD*E* | A——D*E* | ABCDE | A—CDE | —— |
| 17 .. | ABCD | ABCDE | ABCDE | A—CD | A—CDE | A—*C*DE | ABCDE | A—CDE | A—CDE | ABCDE | ABCDE | A—CDE |
| 18 .. | ABCD | ABCDE | ABCDE | A—CD*E* | A—CDE | A——D— | ABCD*E* | A—CDE | A—C—E | A——D*E* | A—CDE | —— |
| 19 .. | ABCD | A—CDE | A—CDE | A—CDE | A—CDE | A——D*E* | A——D— | A—CDE | ABC—E | A—CDE | ABCDE | A—CDE |
| 20 .. | A—CD | ABCDE | A—CDE | A—CDE | A—CDE | A—CDE | A——— | A—*C*D— | A—C—E | ABCD*E* | ABCDE | A—CDE |
| 21 .. | ABCD | ABCDE | A—CDE | A—CDE | A—CDE | ABCDE | A——D— | A——D*E* | A—CDE | A—CDE | A—CDE | ABCDE |
| 22 .. | ABCD | ABCDE | A—CDE | A—CDE | A—CDE | A—CDE | A——D— | ABCDE | A—CDE | ABCDE | A—CDE | A—CD*E* |
| 23 .. | ABCD | ABCDE | A—CDE | ABCDE | A—CDE | A—*C*D*E* | A——D— | A—CD*E* | ABCDE | A—CDE | A—*C*D*E* | ABCDE |
| 24 .. | ABCD | ABCDE | A—CDE | ABCDE | A—CDE | ABCDE | A—*C*D*E* | A—CDE | A——D*E* | A——D*E* | A——D*E* | A—CDE |
| 25 .. | ABCD | ABCDE | A—CDE | ABCDE | A—CDE | A—CDE | A—CD*E* | A—CDE | A—*C*D*E* | —— | A—CDE | A—CDE |
| 26 .. | ABCD | ABCDE | A—CDE | ABCDE | A—CDE | A—CDE | A—*C*D*E* | —— | ABCDE | A—CDE | A—*C*D*E* | A—CDE |
| 27 .. | ABCD | ABCDE | A—CDE | A——D— | A—CDE | A—CDE | —— | ABCDE | A—CDE | A—CDE | A—CDE | A—CDE |
| 28 .. | ABCD | ABCDE | A—CDE | A—CD*E* | A—CDE | A—CDE | A—CD*E* | ABCDE | A—CDE | A—*C*DE | A—CDE | A—CDE |
| 29 .. | ABCD | | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | A—*C*DE | A—CDE | A—CDE |
| 30 .. | ABCD | | A—CDE | A—CDE | A—CDE | —— | A—CD*E* | A——D*E* | ABCDE | A—CDE | A—CDE | A—CDE |
| 31 .. | ABCD | | A—CDE | | ABCDE | | A—CDE | ABCD*E* | | A—*C*D*E* | | A—CDE |

*Note.*—Where a letter is in italics it means that on that day observations were not complete.

SOLAR Observations—Abstract.

| | 1907. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | January. | February | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Total. |
| A | 30 | 28 | 31 | 30 | 31 | 29 | 29 | 30 | 30 | 29 | 27 | 28 | 352 |
| B | 26 | 27 | 18 | 11 | 7 | 4 | 4 | 4 | 10 | 6 | 4 | 8 | 129 |
| C | 27 | 28 | 31 | 29 | 31 | 22 | 22 | 18 | 27 | 24 | 18 | 28 | 305* |
| D | 29 | 28 | 31 | 30 | 31 | 25 | 28 | 30 | 27 | 29 | 23 | 28 | 339 |
| E | * | 28 | 31 | 28 | 31 | 24 | 23 | 25 | 30 | 29 | 23 | 28 | 300 |

* Siderostat had been dismantled for erection of new sliding roof.

6. **Photographs of the sun** with the Dallmeyer photoheliograph were taken on 339 days against 317 in 1906. During February, March, April, and May no days were missed. Seven were missed in November and five in June. During the year it was possible to send to Greenwich all the solar negatives required to fill in the gaps in the Greenwich and Dehra Dun set of daily photographs, and all but one of those that were required to replace photographs that were reported to be ill-defined. A copy of each sun photograph is printed in P.O.P. and is kept for ready reference.

7. **Observations of sunspots.**—The sun is examined for spots and faculæ every morning when the weather permits. The sun's image is projected on an 8-inch disc and the positions of the spots and faculæ are marked on it. There were only 13 days in the year on which this class of observation could not be made.

8. **Sunspot spectra.**—The record of the most prominent widened lines in spot spectra was carried out as heretofore until March 1 when it was discontinued, and, in accordance with the recommendation of the International Union of Solar Research, particular attention was given to the region of spectrum between $\lambda$ 5210 and F, the affected lines being compared directly with Hale's photographic map of the spot spectrum. As the whole region is too extensive to be examined completely on any one day it is observed in successive portions on different days.

Simultaneously with the visual observations a photographic investigation of the spectrum of some of the larger spots has been successfully carried out, using spectrographs I. and II. The plates obtained show a vast amount of detail and cover the regions D to F and H$\gamma$ to H$\delta$. Some of the results of an examination and measurement of these plates have been published during the year and a more detailed discussion of one of the plates is still in progress.

9. **Prominences.**—Prominences were recorded visually on 306 days against 269 in 1906. On 18 of these days the observations were either not complete or not considered satisfactory on account of poor seeing. The record of the prominences is made round the disc on which the spots and faculæ have been projected. The record is compared with the photographs taken with the spectroheliograph and all prominences shown in the photograph but not in the drawing are added in blue pencil. Where there is much difference between the photograph and the drawing, the differences are noted. In the case of eruptive or metallic prominences the spectra are examined and the most conspicuous bright lines are recorded. All conspicuous displacements of the C line are also noted and their amounts estimated.

10. **Spectroheliograms.**—Photographs with the spectroheliograph were taken on 300 days out of 334 possible days during the eleven months the instrument was in use. On 45 of these days the results were not satisfactory owing to unfavourable weather. Many excellent photographs have however been obtained when the conditions were apparently very unfavourable owing to strong sky glare due to cirrus clouds. As a rule, only a very short time is available in the early morning when the definition is good enough to secure fine detail in the photographs, and in cloudless

weather the hour between 8 and 9 A.M. is the best. Usually four negatives of the disc and two of the limb are taken every day. Measures are made of the position angles and heights of the prominences on the best limb photograph of each day and an enlarged positive of the best disc photograph is made on bromide paper. All such positives obtained during a month are correctly oriented and pasted on a large card board sheet, this being found very convenient for a general study of the markings.

Prominence spectroheliograms for 53 days were received from the Solar Observatory, South Kensington, and flocculi plates for 291 days were sent in exchange.

*General Spectroscopic work.*—In addition to spot spectrum work, spectrograph II. has been employd in photographing the chromosphere line Hδ under various conditions, with a view to an accurate determination of its wave-length in the solar spectrum. The general result of a measurement of the plates so far obtained goes to show that Rowland's value for this line (4102·000) is about 0·10 A too large and that the line does not deviate appreciably from its theoretical position according to the formula of Balmer.

An investigation is also in progress with this instrument for determining the rotation period of the higher gases in the chromosphere.

Photographs of the spectrum of comet 1907 d were obtained with a prismatic camera attached to the 6-inch Cooke Equatorial. The results have been communicated to the Royal Astronomical Society.

*Summary of Results.*

11. **Sunspots.**—The following table shows the monthly number of new groups observed, the mean daily number of spots visible, and the distribution between the northern and southern hemispheres :—

| | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups .. .. | 30 | 32 | 28 | 33 | 18 | 17 | 20 | 22 | 36 | 30 | 18 | 17 | 301 |
| Daily number .. .. | 5·9 | 7·1 | 5·3 | 5·3 | 3·1 | 2·7 | 3·1 | 4·3 | 6·0 | 4·9 | 4·0 | 3·7 | 4·6 |
| North .. .. .. | 25 | 17 | 16 | 10 | 8 | 6 | 8 | 8 | 18 | 17 | 7 | 5 | 145 |
| South .. .. .. | 5 | 15 | 12 | 23 | 10 | 11 | 12 | 14 | 18 | 13 | 11 | 12 | 156 |

The total number of new groups seen during the year was 301 against 297 last year. On no day was the sun's surface observed to be free from spots. There were seventeen days on which only one group was visible. Ten groups or more were visible on five days.

The distribution of the groups between the two hemispheres was more nearly equal this year than during the preceding years. For seven months there were more spots in the southern than in the northern hemisphere.

The mean daily number of groups varied from 2·7 in June to 7·1 in February and the average for the year was 4·6. The mean latitude of the spots was 10°·9 in the northern hemisphere and 12°·4 in the southern. There were four groups within 1° and four other groups within 2° of the equator. The most important groups seen during the year were the following :—

No. {1010, 1034, 1061, 1094, 1116} This group came round the limb on December 12 last year as a large regular spot with a few small companions and finally disappeared on the visible disc not far from the western limb on April 14. This spot is interesting as having persisted for five solar rotations, lasting for over four months, and undergoing immense changes during its course. In

January it was scattered over 10° of latitude and 19° of longitude and it remained a huge scattered group during February also. In March most of the smaller companions had disappeared and the main spot also was decreased in size. In April it was a small round and regular spot when it came round the east limb, but was reduced to a single dot for two days before its final disappearance. The spectrum of the spot showed great disturbance during most of its course.

No. 1051 / 1081 came round the limb on January 27 and consisted of a leading large spot with a double umbra and a large train of followers. On the 30th its spectrum showed great disturbance in the hydrogen line, and $D_3$ was intensely dark. It was seen during two rotations.

No. 1057 / 1090 came round the limb on February 4. It was at first irregular in outline and had many small companions, but by the time it had reached the central meridian most of the companions had disappeared and the main spot had increased in size and had become more regular in shape. The umbra was a double one. It returned again on March 3 as a round and regular spot and traversed the disc unchanged until it disappeared at the west limb on the 15th.

No. 1058 / 1086 formed on the visible disc on February 5. It rapidly developed and on the 9th it consisted of two pairs of regular spots close together. It returned again on February 28.

No. 1075 was first seen on February 20 and was formed on the visible disc. It rapidly developed and after it had crossed the central meridian, on the 23rd, it consisted of three moderate-sized spots in a train.

No. 1115 which appeared at the east limb on March 31 was the only large spot seen during April.

No. 1145 formed on the visible disc on May 3, about a day's journey from the central meridian. It rapidly developed till the 6th when it attained its maximum size. This was a very disturbed spot.

No. 1146 came round the east limb on May 4. It was a large group visible to the naked eye, and at first consisted of a main spot with double umbra and smaller companions. The umbræ afterwards became united. The main spot became smaller as it approached the west limb and the umbra again divided into two.

No. 1148 was first seen on May 7 as two small dots half way between the east limb and the central meridian. It grew day after day till the 11th after which it began to decrease in size.

No. 1175 was first observed here on June 14 not far from the east limb. It consisted, in the beginning, of 3 distinct moderate-sized spots of regular outline very near each other. This was one of the largest spots seen during the year and was visible to the naked eye.

No. 1185 was on the sun from July 11 to 23. This was a spot of round and regular outline quite free from smaller companions. The spectrum indicated some disturbance on the 14th when the C line was strongly reversed close to it.

No. 1187 came round the east limb on July 12 and was in about the same region as that occupied by the larger spot (No. 1175) of June. In the beginning it consisted of a double spot but the rear companion soon broke up into smaller dots.

No. 1189 was a small spot when it was first seen near the east limb on July 20. It soon developed and attained its maximum size on the 26th, when it was on the central meridian, after which it became smaller.

No. 1210 came round the east limb on August 14 and consisted, in the beginning, of a long stream extending over nearly 14° of longitude It contained two main spots, one leading and the other at the rear.

No. 1215 was first seen near the east limb on August 27 and consisted of a train of three spots with a number of small companions. It traversed the disc without undergoing much change and disappeared at the west limb on September 9.

No. 1228 was visible from September 6 to 18. It developed from small dots into a long scattered group.

Nos. 1237 and 1241 were visible from September 12 to 24 and 17 to 28 respectively. They were single spots of round and regular outline. They traversed the solar disc without undergoing any great change.

No. {1242, 1273} came round the east limb as a small dot on September 17. The number and size of the spots increased from day to day. On the 26th it was a train extending over 20° of longitude. It appeared again on October 14 and traversed the solar disc as a long train with a chief spot leading. On several occasions the hydrogen lines were seen reversed close to the spot.

No. 1267 came round the east limb on October 9 and was growing for the next five days, after which it began to decrease in size until it disappeared round the west limb on the 21st.

No. 1292 came round the east limb on November 9 and was last seen on the 22nd. It underwent little change from day to day and remained a long train containing several large spots and extensive penumbral patches. On November 20, when it was near the west limb, the spectrum showed considerable disturbance. The group was also associated with intensely bright metallic prominences at the west limb.

Nos. 1288 and 1293 were also fairly large spots which appeared in November but they did not show any activity, nor did they undergo any marked changes from day to day except that No. 1293 dwindled as it neared the west limb.

Nos. 1304, 1306 and 1307 were fairly large spots that were seen in December, but there was nothing striking about them.

No. 1311 was first observed on December 14 as a train of small spots and in the course of a few days formed a fine double spot-group.

No. 1312 came round the limb on December 15. This was associated with prominences at both limbs and showed C reversed on the umbra on the 22nd, 23rd, and 27th.

No. 1321 came round the east limb on December 31.

12. **Prominences.**—The general activity of the two hemispheres for all classes of prominences, as compared with the previous year, may be inferred from the following table:—

*Mean daily profile areas of Prominences.*

| | 1906. | | 1907. | |
|---|---|---|---|---|
| North | 2·51 | square minutes. | 1·92 | square minutes. |
| South | 2·17 | ,, ,, | 2·27 | ,, ,, |
| Total | 4·68 | ,, ,, | 4·19 | ,, ,, |

It is seen from the above that the general reduction of activity in 1907 is confined to the northern hemisphere, the southern showing a slight increase. In the latitude distribution a remarkable difference is shown between the two hemispheres, which are usually more or less symmetrical as regards the latitudes of the zones of maxima and minima. From the beginning of the year the northern polar prominences, which were strongly represented during 1906, practically ceased to exist, whilst the

south polar region still continued active, the whole region between — 45° and the south pole producing a very considerable number of large prominences. The region from latitude — 10° to — 45° has been the most prolific, however, in this hemisphere; but no clearly marked zones of maxima are shown. In the north, on the other hand, two well-defined maxima occur in the zones + 25° to + 30° and + 50° to + 55°.

Metallic prominences were of frequent occurrence, 111 having been recorded. Of these, 54 were confined to the northern spot zone, and had a mean latitude of +15°·7, 50 were confined to the southern spot zone, with a mean latitude of — 15°·6, the remaining 7 were distributed in longitude in a narrow zone entirely outside the spot regions, the mean latitude being — 72°. The only metallic elements observed in these high latitude prominences were Na, Mg, and Fe, whilst some of the prominences in spot-latitudes gave, in addition, the lines of Ba and Ca, together with a considerable number of unidentified lines, probably including Ni, Mn, Cr, and Ti.

As a full list of prominences observed is being published in the Bulletins of the Observatory it is only necessary to give here a few notes of the more important prominences of the year.

*January*.—Large prominences were abundant. No less than 71 reached a height of about 1 minute and upwards, and of these 9 were over 2 minutes high. The tallest seen was on the 24th at position angle 72° and this reached a height of 210 seconds.

*February*.—Large prominences were as abundant as in January. Seventy-five prominences of over 1 minute in height were recorded and of these 10 were more than 2 minutes high. The tallest was one seen on the 4th at position angle 90° which reached a height of 210 seconds.

*March*.—Large prominences were abundant, as in previous months. There were 50 which were equal to or exceeding a minute in height and 30 covering 10° or more of the solar limb. Six were two minutes or more in height. The tallest of the month and perhaps the highest recorded here was photographed in Ca light on the 14th at $9^h\ 25^m$ between position angle 3° and 15°. It was $6\frac{1}{2}$ minutes high, and was probably eruptive as it was absent from two other photographs taken half an hour and one hour later. On the 20th a huge cloud, about 150″ high and overhanging 25° of the limb between position angles 95° and 110°, was photographed.

*April*.—There were 59 prominences of 1 minute or more in height. On the 9th and 22nd prominences were observed extending over about 30° of the solar limb. On the former date, at position angle 30°, a fine prominence of a very complicated structure and covering nearly 20° of limb was seen, and a series of photographs showed that in an interval of 39 minutes it increased in height from 105″ to 135″.

*May*.—There were as many as 87 of about or more than a minute in height. Four of these were 2 minutes high and two exceeded $4\frac{1}{2}$ minutes. The tallest was 290″ high and was observed and photographed on the 3rd at position angle 45°. On May 8 a very large number of prominences covered the solar limb and almost a continuous series of prominences, large and small, extended from position angle 25° to 100°.

*June*.—Owing to poor observing weather during the greater part of the month only 22 large prominences were recorded. The tallest was 140″ high and was photographed on the 24th at position angle 152°.

*July*.—There were 28 large prominences observed on the 19 days when observations were possible. On the 4th, at position angle 266°, an intensely bright eruptive prominence was photographed which was rapidly increasing in height. It was 200″ high at $8^h\ 10^m$ I.S.T. and about $8^m$ later it had attained a height of 315″, or nearly 142,000 miles.

*August*.—There were only 28 large prominences observed during the month. The highest was about two minutes in altitude, and was photographed on the 22nd at position angle 343°.

*September*.—There were 47 large prominences observed, of which seven were two minutes or more in height. The tallest recorded was two and a half minutes high, and was observed on the 10th at position angle 288°.

*October*.—There were 39 large prominences observed, of which eight were about two minutes high. The tallest recorded was on the 30th and was 150″ high.

*November.*—Twenty-five prominences were observed in the month a minute or more in height. The highest was a detached cloud 180″ high photographed on the 2nd. Metallic prominences were observed on the 21st and 22nd associated with spot 1292 referred to above.

*December.*—Fifty-eight prominences of one minute or more in height were observed in the month. A region about latitude + 45° West and covering more than 50° of longitude contained a series of prominences two minutes or more in height. The highest one, a cloud 170″ high, was seen on the 26th. On the 5th there was a closely connected group of prominences occupying more than 30° near the east limb. There were seven metallic prominences observed during the month.

(*b*) OTHER OBSERVATIONS.

13. **Time.**—Time is determined with the transit instrument when necessary. The standard clock and the chronometers are compared and rated daily.

The standard clock is also compared daily with the Madras standard clock by means of the signals sent at 4 P.M. over all telegraph lines in India.

The usual time signal to the station was not given throughout the year owing to the failure of the Public Works Department to repair the flagstaff. A new flagstaff is now in course of erection and the time signal, which is much appreciated, will be restarted as soon as the new staff is ready.

14. **Meteorology.**—Meteorological observations were carried on as in former years. Eye observations are made at $8^h$, $10^h$, and $16^h$ local mean time. Temperatures and pressure are recorded by a Richard thermograph and barograph and the mean daily pressure and temperature are obtained from the traces corrected by reference to the eye observations. The wind direction and velocity are got from a Beckley anemograph placed on a tower sufficiently far from the observatory to be undisturbed by the buildings.

*Temperature.*—The mean temperature for the whole year was 0°·4 below the assumed average. The only months in which there was any considerable difference from normal were April and August, in the former of which the temperature was 1°·7 and the latter 1°·9 below normal. The highest shade temperature recorded was 74°·7 on June 3, and the lowest 40°·8 on January 15 and December 25. The highest temperature in the sun was 147°·6 on June 21, and the lowest grass minimum 19°·9 on January 20.

*Humidity.*—The relative humidity was largely below normal in May and largely above normal in March and April. For the whole year it was 1 per cent. above normal.

*Winds.*—The wind velocity was above average in May, August, November, and December and below it in all other months. In August the excess was 102 miles per day and in July the defect was 68 miles per day. The highest daily records were 809 miles on November 5 and 785 miles on August 7.

*Rain.*—The rainfall for the year was nearly 20 per cent. below normal. It was normal in March and May, in considerable excess in November, and in defect in all other months, the greatest defect being 4·9 inches in October. The greatest fall in one day was 3·63 inches on November 19.

*Cloud and sunshine.*—The sunshine recorded for the year was a little above the normal. It was considerably in excess in January, February, and May and considerably in defect in August.

The transparency of the lower atmosphere as judged by the visibility of the Nilgiris was much below the average. It was the lowest recorded since 1901.

15. **Seismology.**—The Milne horizontal pendulum was in use throughout the year and the results are given in Appendix I., but during part of the time the records were not quite satisfactory. This was probably owing to the fact that the point of the pivot had got blunted. This has now been rectified. The number of distant earthquakes recorded was only 24, which is far the smallest number for any year since the instrument was set up. Copies of the records and of the chief seismograms are supplied to the British Association Committee and to others when asked for.

16. **Library.**—A card catalogue of the library, which was begun some time ago but was not carried far owing to pressure of work, has been almost completed by Mrs. Evershed. One hundred and fifty-one volumes were bound during the year.

17. **Publications.**—Bulletins Nos. VIII. to XI. were published and distributed during the year, and No. XII. was in type at the close of the year.

Bulletins Nos. VIII. and XI. give the observations of sunspot spectra made between January 1906 and February 1907. Nos. IX. and X. contain lists of prominences observed from January to December 1906. No. XII. will bring the latter record up to the end of June 1907.

In addition to these the following papers were published by members of the staff :—

"Distribution of prominences in latitude in the year 1906 from observations made at Kodaikánal on 156 days in the first half of the year and 105 days in the second half by J. Evershed." R.A.S. M.N. LXVII., 7.

"The ultra-violet region in sunspot spectra", and

"The spectrum of Comet 1907d (Daniel)" by J. Evershed, R.A.S. M.N. LXVIII., 1.

"The Weakened and Obliterated lines in the sunspot spectrum," by G. Nagaraja. A.P.J. XXVI., 3.

18. **General.**—The Director-General of Observatories visited Kodaikánal and Madras at the end of January and the beginning of February. The Officiating Director inspected the Madras Observatory in November. The whole staff worked well throughout the year.

The Director, when on leave, took part in the Paris Meeting of the International Congress for Solar Research, and then and on other occasions had an opportunity of discussing many points connected with the work of the Observatory with the chief authorities on the subject.

Kodaikánal,
13*th February* 1908.

C. Michie Smith,
*Director, Kodaikánal and Madras Observatories.*

## II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1907.

**Staff.**—Mr. R. Ll. Jones went on 16 months' leave from the 6th May and I took over charge from him on that date. There was no change in the permanent ministerial staff of the Observatory.

Mr. S. Solomon Pillai took privilege leave for one month from the 19th April and again for one month from the 7th December on account of ill-health. His leave has since been extended by another month. On the first occasion, Mr. C. N. Ramaswamy Aiyangar, M.A., acted as First Assistant and on the present occasion Mr. A. A. Narayana Aiyar, B.A., is acting as First Assistant.

Mr. M. G. Subrahmanyam is under orders of transfer to Bombay and his place will be filled by Mr. A. A. Narayana Aiyar.

2. **Time service.**—The astronomical observations made during the year were, as usual, solely directed to time determinations. Transits of the sun were also taken occasionally to check the rate of the clock when unfavourable weather prevented the regular star observations from being taken.

The time gun at the Fort was fired correctly at noon and at 8 P.M. on 709 occasions out of 730, giving a percentage of success of 97·1.

The time ball at the Port office was dropped at 1 P.M. correctly on all occasions except four. On three of these it was dropped correctly at 2 P.M.

The 8-hour and 16-hour rolls were sent as in the previous years except that the 60th seconds are now being omitted in the 8-hour rolls also from 1st October, at the request of the Master Attendant, Colombo. Both the 8-hour and 16-hour rolls were found to be not quite satisfactory, the intervals between successive seconds being sometimes unequal. An entirely automatic arrangement for sending the roll has been suggested and is now under consideration. It would, in eliminating the personal equation, be a distinct improvement.*

3. **Meteorological observations.**—Meteorological observations were made as usual at 8, 10, 16 and 20 hours, local mean time. The observations of the 10 and 16 hours were reduced and sent to the India Meteorological Office, Alipore, on Form F. The original method of observing the movement of clouds was discontinued from the 1st March, from which date the present method, personally explained by Mr. J. H. Field, Imperial Meteorologist, has been used.

Besides the ordinary weather messages, special storm observations were sent on one occasion to Simla and on 138 occasions to Calcutta.

The tabulation of the traces of the Barograph, Thermograph and Anemograph at Madras and of the Anemograph at Dodabetta are up to date.

4. **Buildings.**—Ordinary repairs to the buildings were made during the year. The dome of the 8-inch equatorial, which is worn out, has not yet been replaced by a new one, but money for a new dome has been provided in the budget for next year.

5. **Instruments.**—The following is the list of instruments at the Madras Observatory on the 31st December 1907 :—

*(a) Astronomical.*

Eight-inch Equatorial Telescope—Troughton & Simms.
Sidereal Clock—Haswall.
,, Dent No. 1408.
,, S. Riefler No. 61.
Mean Time Clock with galvanometer—Shepherd & Sons.
Meridian Circle—Troughton & Simms.
Mean Time Clock—J. Monk.
Mean Time Chronometer—V. Kullberg 5394.
,, ,, 6544.
,, Parkinson & Frodsham 2352.
Portable Transit Instrument—Dolland.

* The final signal at 16h is sent by the clock and is not affected by the personal equation of the sender.

Portable Telescope with stand.
Tape Chronograph—R. Fuess.
Relay for use with the Chronograph—Siemens.

(*b*) *Meteorological.*

Richard's Barograph—No. 10 L. Casella.
Richard's Thermograph—No. 3618 L. Casella.
Beckley's Anemograph—Adie.
Sunshine Recorder—No. 149 L. Casella.
Anemoscope—P. Orr & Sons.
Nephoscope—Mons. Jules Dabosq & Ph. Pellin.
Barometer, Fortin's—1771 L. Casella.
Barometer, Fortin's—725 L. Casella (spare).
Barometer, Fortin's—1420 L. Casella (spare).
Dry bulb thermometer—No. 94221 L. Casella.
Dry bulb thermometer—No. 38037 Negretti & Zambra (spare).
Wet bulb thermometer—No. 94219 L. Casella.
Wet bulb thermometer—No. 38037 Negretti and Zambra (spare).
Dry maximum thermometer—No. 8581 Negretti and Zambra.
Dry minimum thermometer—No. 69047 L. Casella.
Wet minimum thermometer—No. 91753 Negretti & Zambra.
Sun maximum thermometer—No. 10479 Negretti & Zambra.
Grass minimum thermometer—No. 3377 Negretti & Zambra.
Raingauge (8″ diameter)—No. 1042 Negretti & Zambra.
Measure glass for above.
Raingauge (5″ diameter).
Measure glass for above.

The Chronograph which was sent out with two connections imperfectly insulated was put in order and brought into use for transit work from the 29th August. The Riefler Clock has been keeping a steady rate, the variation between the maximum and minimum daily rate throughout the year being only 0·31 seconds. Towards the end of the year the catgut cord of the Riefler Clock was replaced by a silk one, the movement was cleaned and oiled, and the aneroid was adjusted. Almost immediately afterwards the second-beats were found to be of unequal length, which necessitated the opening of the clock again for adjustment.

The Acting Director, Kodaikánal and Madras Observatories, visited the Madras Observatory in November and cleaned the object-glass of the Equatorial and the wires of the Meridian Circle.

6. **Weather Summary.**—The following is a summary of the meteorological conditions at Madras during the year 1907 :—

*Pressure.*—The atmospheric pressure was above normal in March, April, May, September and October, and below normal in the other months of the year. The greatest excess was 0·020 inches in April and the greatest defect was 0·031 inches in November. The highest pressure recorded was 30·098 inches on December 29, the lowest pressure was 29·518 inches on July 25.

*Temperature.*—The mean temperature of the air was normal in January and December, and above normal in all the other months except April, when it was below normal. The maximum in the shade was above normal in March, May, June, July, August and September and below normal in the other six months, the greatest excess being 4°·3 F. in May and the greatest defect being 1°·5 F. in November. The minimum in the shade was normal in May, below normal in January, April, and December, and above in the remaining months of the year; that on grass was normal in April and above normal in the other 11 months. The maximum in the sun was below normal throughout the year, the greatest defect being 12°·4F. in November. The highest temperature in the sun was 151° 2·F. on August 27, and that in the shade was 109°·0 F. on May 24. On January 31, the lowest temperature in the shade (59°·6F.) and on grass (55°·2 F) occurred.

*Humidity.*—The humidity was below normal in May, June, and August, and above in all the other months. The lowest percentage was 29 on October 15.

*Wind.*—The wind direction was normal in January, May, and July. It was more northerly in October and December, more easterly in March, April, and November, more southerly in February and September, and more westerly in June and August.

The wind velocity was above normal in March, August, and November, and below normal in the remaining months, the greatest deficiency in the mean daily velocity being 46 miles per diem in May.

*Cloud.*—The percentage of cloud was in slight excess in April and November and in defect in all the other months.

*Sunshine.*—The percentage of bright sunshine was above normal in July and September and below normal in the remaining months. The greatest defect was 16·5 in November. There were 2,234·6 hours of bright sunshine during the year.

*Rainfall.*—The rainfall was above the average in June, October, November, and December, and below in the other eight months. The greatest defect was 4·40 inches in September, the fall in the month being only 7 per cent. of the average amount. The rainfall from the 15th October to the end of the year was 24·99 inches against an average of 26·00 inches. The total rainfall for the year was 44·68 inches—4·34 inches below the normal. The greatest fall on a single day was 5·06 inches on October 2.

*Storm.*—A cyclone of moderate intensity, which formed in the Andaman Sea, crossed the Madras Coast between Madras and Nellore on the afternoon of the 26th November. The rainfall received on that day was 3·18 inches.

MADRAS OBSERVATORY,
18*th January* 1908.

R. LITTLEHAILES,
*Officiating Deputy Director.*

# Appendix I.

KODAIKÁNAL Observatory Seismological Records in 1907.

| No. | Date. | | P.T. Commence G.M.T. | | L.W. Commence G.M.T. | | Maxima G.M.T. | | End G.M.T. | | Max. Amp. | | Duration. | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1907. | | H. | M. | H. | M. | H. | M. | H. | M. | MM. | " | H. | M. | |
| 1 | Jan. | 2 .. | 12 | 15·8 | 12 | 24·9 | 12 | 36·4 | 13 | 50 | 0·6 | 0·3 | 1 | 34 | |
| | | | | | | | 13 | 15·6 | | | 0·5 | 0·3 | | | |
| 2 | | 4 .. | No. P. Ts. | | 5 | 23·8 | 5 | 30·2 | 8 | 34 | .. | | 3 | 10* | |
| | | | | | | | 5 | 41·2 | | | | | | | |
| 3 | | 4 .. | 9 | 50·5? | 10 | 5·9 | 10 | 9·0 | 10 | 35 | 0·6 | 0·3 | 0 | 44 | |
| 4 | | 8 .. | 5 | 40·9 | 6 | 3·8 | 6 | 12·0 | 7 | 7 | 0·7 | 0·3 | 0 | 44 | |
| 5 | Feb. | 3 .. | No. P. Ts. | | 19 | 56·7 | 19 | 57·7 | 20 | 37 | 0·4 | 0·2 | 0 | 40 | |
| 6 | Mar. | 29 .. | 20 | 53·6 | 21 | 3·1 | 21 | 4·1 | 21 | 57 | 1·0 | 0·54 | 1 | 03 | Bitlis. |
| 7 | | 31 .. | No. P. Ts. | | 22 | 24·2 | 22 | 25·2 | 23 | 12 | 0·6 | 0·27 | 0 | 48 | |
| 8 | Apr. | 13 .. | Do. | | 18 | 48·9 | 18 | 51·0 | 19 | 54 | 0·6 | 0·27 | 1 | 05 | |
| 9 | | 15 .. | 6 | 30·0 | 7 | 32·9 | 7 | 42·1 | 8 | 28 | 2·1 | 1·14 | 1 | 58 | Mexico |
| 10 | | 18 .. | 21 | 9·0 | 21 | 26·9 | 21 | 32·6 | 22 | 23 | 1·6 | 0·77 | 1 | 14 | |
| | | | | | | | 21 | 39·2 | .. | | 1·5 | 0·72 | .. | | |
| 11 | | 19 .. | 0 | 0·8 | 0 | 20·2 | 0 | 25·3 | 1 | 25 | 1·95 | 0·94 | 1 | 24 | |
| 12 | | 26 .. | 19 | 18·6 | 19 | 24·1 | 19 | 25·8 | 19 | 40 | 0·75 | 0 32 | 0 | 22 | |
| 13 | May | 25 .. | 12 | 0·2 | 12 | 24·3 | 12 | 25·4 | 12 | 41 | 0·25 | 0·12 | 0 | 41 | |
| 14 | | 25 .. | 14 | 18·2 | 14 | 29·0 | 14 | 29·5 | 14 | 48 | 0·50 | 0·24 | 0 | 30 | |

There were some very small tremors on May 31 at 13h 12m, on June 1st from 10h to 10h 30m and also on June 24—maximum at 16h 36m (G.M.T).

| No. | Date. | | P.T. Commence G.M.T. | | L.W. Commence G.M.T. | | Maxima G.M.T. | | End G.M.T. | | Max. Amp. | | Duration. | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | June | 25 .. | 18 | 2·5 | 18 | 9·6 | 18 | 10·2 | 18 | 59 | 1·5 | 0·68 | 0 | 57 | |
| 16 | Sept. | 2 .. | 16 | 14·7? | 16 | 17·5 | 16 | 18·1 | 18 | 07 | 0·5 | 0·3 | 1 | 52 | |
| 16a | | 5 .. | Small | | Tremors | | 23 | 03 | and | | 23h 29m | | Ending at 23h 40m | | |
| 17 | Oct. | 4 .. | 10 | 39·2 | 10 | 43·3 | 10 | 45·3 | 11 | 16 | 2·4 | 0·9 | 0 | 37 | |
| 17a | | 5 .. | Small | | Tremors | | From | | 3 | 56 | to 4h 01m | | .. | | |
| 17b | | 11 .. | .. | | Do. | | .. | | 15 | 15 | to 15h 32m | | .. | | |
| 18 | | 21 .. | 4 | 34·0 | 4 | 36·0 | ? | | 6 | 37 | ? | | 2 | 03 | Boom went to one side. |
| 19 | | 27 .. | 5 | 28? | 5 | 32·2 | 5 | 32·8 | 5 | 47 | 2·2 | 0 9 | 0 | 19 | Sheet marked at 5h 21m. |
| 19a | Nov. | 12 .. | Small | | Tremors | | From | | 8 | 06 | to 8 | 16 | .. | | |
| 19b | | 16 .. | .. | | Do. | | .. | | 22 | 20 | to 22 | 41 | .. | | |
| 20 | | 21 .. | 20 | 09·0 | 20 | 13·0 | 20 | 15·0 | 21 | 20 | 4·5 | 2·2 | 1 | 11 | Karadagh. |
| 21 | | 22 .. | No. P. Ts. | | 6 | 17·0 | 6 | 19·0 | 6 | 32 | 0·8 | 0·4 | 0 | 15 | |
| 22 | Dec. | 5 .. | 12 | 48·0 | 12 | 53·2 | 12 | 57·8 | 13 | 16 | 0·5 | 0·2 | 0 | 28 | |
| 23 | | 15 .. | No. P. Ts. | | 17 | 54·8 | 17 | 55·9 | 18 | 54 | 0·4 | 0·2 | 0 | 59 | Many small maxima. |
| 24 | | 30 .. | 5 | 57·2 | 6 | 06·0 | 6 | 08·0 | | | | | | | |
| | | | | | | | 7 | 13·0 | 7 | 38 | 0·5 | 0·2 | 1 | 41 | |

* Several very large maxima reaching to at least 25mm—largest uncertain. Sheet changed at 6h 46m (G.M.T.).

# Appendix II.

Latitude—10° 13′ 50″ N.
Longitude—5h 09m 52s E.

Height of barometer cistern above sea level 7,688 feet.

MEAN monthly and annual Meteorological Results at the Kodaikánal Observatory in 1907.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer. Mean. | Dry bulb thermometer. Max. | Dry bulb thermometer. Min. | Dry bulb thermometer. Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. By Blanford's tables. | Relative humidity. By Blanford's tables. | Sun Max. *in vac.* | Min. on grass. | Wind. Daily velocity. | Wind. Mean direction. | Wind. Mean direction. | Rain. Amount. | Rain. Days. | Clear sky. | Bright sun-shine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | POINTS. | POINTS. | INCHES. | NO. | CENTS. | HOURS. |
| January .. | 22·834 | 0·069 | 53·1 | 62·8 | 46·3 | 16·5 | 46·9 | 40·6 | 0·265 | 66 | 115·1 | 36·1 | 261 | 6 | E. N. E. | 0·97 | 1 | 64 | 248·6 |
| February .. | ·844 | ·070 | 55·3 | 67·6 | 47·6 | 20·0 | 47·6 | 41·5 | ·259 | 59 | 124·9 | 36·7 | 294 | 6 | E. N. E. | .. | .. | 74 | 248·9 |
| March .. | ·851 | ·072 | 57·0 | 68·4 | 51·0 | 17·4 | 50·2 | 44·6 | ·300 | 64 | 129·9 | 41·5 | 296 | 8 | E. | 1·79 | 4 | 69 | 244·8 |
| April .. | ·821 | ·078 | 57·7 | 67·3 | 52·2 | 15·1 | 53·4 | 47·9 | ·368 | 77 | 131·0 | 44·5 | 253 | 9 | E. by S. | 6·26 | 9 | 46 | 200·9 |
| May .. | ·822 | ·072 | 60·5 | 70·2 | 54·4 | 15·8 | 53·9 | 49·3 | ·351 | 66 | 130·3 | 47·2 | 280 | 6 | E. N. E. | 5·37 | 9 | 59 | 229·2 |
| June .. | ·758 | ·060 | 57·9 | 65·5 | 53·6 | 11·9 | 53·6 | 49·2 | ·370 | 77 | 123·6 | 48·5 | 344 | 26 | W. N. W. | 1·94 | 7 | 33 | 132·7 |
| July .. | ·742 | ·059 | 56·3 | 62·7 | 52·7 | 10·0 | 53·7 | 50·4 | ·389 | 85 | 114·7 | 48·0 | 380 | 23 | W. by S. | 3·90 | 13 | 24 | 101·4 |
| August .. | ·776 | ·068 | 54·9 | 61·1 | 51·8 | 9·3 | 52·7 | 49·7 | ·379 | 88 | 115·7 | 48·7 | 426 | 27 | N.W. by W. | 6·36 | 11 | 17 | 71·6 |
| September .. | ·796 | ·075 | 56·4 | 63·6 | 52·0 | 11·6 | 53·6 | 49·7 | ·385 | 84 | 122·7 | 46·5 | ·257 | 31 | N. by W. | 3·64 | 9 | 35 | 128·9 |
| October .. | ·812 | ·080 | 55·5 | 62·3 | 51·4 | 10·9 | 52·9 | 49·3 | ·378 | 85 | 116·0 | 46·8 | ·265 | 1 | N. by E. | 6·24 | 10 | 29 | 123·8 |
| November .. | ·810 | ·071 | 53·9 | 60·4 | 49·9 | 10·5 | 51·2 | 46·6 | ·354 | 84 | 109·7 | 44·9 | ·307 | 3 | N.E. by N. | 10·02 | 13 | 27 | 123·9 |
| December .. | ·819 | ·068 | 52·8 | 61·6 | 46·9 | 14·7 | 47·1 | 40·6 | ·273 | 68 | 111·9 | 39·9 | ·324 | 3 | N.E. by N. | 1·97 | 5 | 51 | 218·9 |
| Annual .. | 22·807 | 0·070 | 55·9 | 64·5 | 50·8 | 13·6 | 51·4 | 46·6 | 0·339 | 75 | 120·5 | 44·1 | 307 | 2 | N.N.E. | 48·46 | 91 | 44 | 2,073·6 |

EXTREME monthly Meteorological Records at the Kodaikánal Observatory in 1907.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry bulb thermometer. Highest. | | Dry bulb thermometer. Lowest. | | Wet bulb. Lowest. | | Humidity. Lowest. | | Sun Th. *in vacuo.* Highest. | | Grass therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest Fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY. |
| January .. | 22·916 | 1 | 22·773 | 18 | 0·143 | 70·4 | 28 | **40·8** | 15 | 32·3 | 28 | 9 | 27 | 128·9 | 24 | **19·9** | 20 | 424 | 5 | 140 | 7 | 0·84 | 6 |
| February .. | ·939 | **27** | ·765 | 2 | ·174 | 72·0 | 13 | 44·9 | 10 | **32·1** | 13 | 10 | 13 | 130·3 | 25 | 30·3 | 6 | 451 | 26 | 126 | 1 | .. | .. |
| March .. | **943** | 5 | ·758 | 13 | ·185 | 72·0 | 15 | 46·0 | 2 | 36·0 | 16 | 9 | 9 | 144·2 | 18 | 35·2 | 8 | 573 | 8 | 171 | 26 | 0·56 | 20 |
| April .. | ·902 | **4** | ·740 | 27 | ·162 | 72.4 | 24 | 48·1 | 4 | 41·3 | 4 | 36 | 24 | 141·4 | 26 | 37·2 | 4 | 390 | 21 | 151 | 28 | 1·12 | 8 |
| May .. | ·919 | 20 | ·742 | 4 | ·177 | 74·3 | 26 | 50·2 | 16 | 41·4 | **7** | 23 | 7 | 140·9 | 14 | 42·4 | 18 | 536 | 6,7 | 146 | 24 | 1·00 | 18 |
| June .. | ·876 | 20,21 | **·639** | 13 | ·237 | **74·7** | 3 | 50·9 | 17 | 42·2 | 23 | 33 | 23 | **147·6** | 21 | 41·7 | 20 | 624 | 13 | 122 | 20 | 0·46 | 9 |
| July .. | ·838 | 10 | ·640 | 24 | ·198 | 67·2 | 11 | 49·7 | 30 | 46·6 | 30 | 55 | 15 | 136·8 | 13 | 43·1 | 8 | 776 | 1 | 147 | 4 | 0·78 | 5 |
| August .. | ·856 | 18 | ·687 | 6 | ·169 | 64·6 | 18 | 49·3 | 27 | 47·2 | 27 | 67 | 29 | 135·1 | 22 | 45·3 | 19 | 785 | 7 | 188 | 18 | 1·37 | 30 |
| September .. | ·874 | 21 | ·726 | 9 | ·148 | 68·5 | 19 | 49·4 | 6 | 44·6 | 8 | 53 | 10 | 139·3 | 10 | 42·4 | 30 | 543 | 5 | 115 | 21 | 0·81 | 22 |
| October .. | ·901 | 11 | ·725 | 3 | ·176 | 68·5 | 19 | 48·1 | 28 | 42·6 | 14 | 43 | 14 | 137·6 | 19 | 40·6 | 28 | 459 | 2 | **110** | 25 | 1·40 | 5 |
| November .. | ·904 | 19 | ·731 | 26 | ·173 | 64·3 | 29 | 45·6 | 13 | 37·1 | 26 | 27 | 26 | 127·2 | 29 | 37·6 | 15 | **809** | 5 | 162 | 28 | **3·63** | **19** |
| December .. | ·894 | 11 | ·734 | 16 | ·160 | 67·7 | 29 | **40·8** | 25 | 32·2 | 6 | **7** | 6 | 129·6 | 7 | 26·5 | **9** | 569 | 17 | 163 | 13 | 0·66 | **17** |

# Appendix III.

KODAIKÁNAL mean hourly Wind Velocity for the year 1907.

| Month. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hours. | | | | | | | | | | | | | | | | | | | | | | | |
| January .. .. .. .. | 12 | 12 | 12 | 12 | 11 | 12 | 11 | 11 | 12 | 12 | 12 | 13 | 13 | 11 | 10 | 9 | 7 | 6 | 8 | 9 | 10 | 11 | 12 | 11 |
| February .. .. .. | 13 | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 15 | 16 | 18 | 17 | 15 | 13 | 11 | 10 | 8 | 6 | 6 | 8 | 8 | 9 | 11 | 13 |
| March .. .. .. .. | 12 | 13 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | 14 | 12 | 11 | 10 | 9 | 8 | 9 | 9 | 8 | 8 | 9 | 12 |
| April .. .. .. .. | 9 | 9 | 10 | 10 | 11 | 10 | 10 | 11 | 11 | 12 | 12 | 13 | 12 | 12 | 12 | 12 | 11 | 10 | 10 | 10 | 10 | 10 | 9 | 9 |
| May .. .. .. .. | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 13 | 14 | 14 | 13 | 12 | 13 | 13 | 12 | 10 | 10 | 10 | 10 | 10 | 10 | 11 |
| June .. .. .. .. | 16 | 16 | 16 | 15 | 16 | 16 | 16 | 14 | 14 | 13 | 13 | 13 | 13 | 12 | 13 | 12 | 12 | 13 | 14 | 16 | 16 | 16 | 15 | 16 |
| July .. .. .. .. | 16 | 16 | 17 | 17 | 17 | 17 | 16 | 15 | 14 | 14 | 15 | 15 | 15 | 15 | 16 | 15 | 14 | 14 | 16 | 16 | 16 | 18 | 17 | 17 |
| August .. .. .. .. | 22 | 21 | 19 | 19 | 18 | 18 | 19 | 16 | 18 | 16 | 16 | 15 | 16 | 15 | 15 | 16 | 17 | 18 | 18 | 19 | 19 | 18 | 19 | 18 |
| September .. .. .. | 13 | 12 | 12 | 12 | 13 | 12 | 11 | 11 | 10 | 10 | 10 | 9 | 9 | 9 | 9 | 10 | 9 | 9 | 9 | 10 | 12 | 12 | 12 | 12 |
| October .. .. .. .. | 11 | 11 | 11 | 11 | 10 | 11 | 12 | 13 | 13 | 11 | 12 | 12 | 11 | 11 | 11 | 10 | 10 | 9 | 10 | 10 | 11 | 12 | 11 | 11 |
| November .. .. .. | 15 | 14 | 14 | 15 | 15 | 14 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 12 | 10 | 10 | 10 | 10 | 12 | 12 | 13 | 13 | 13 | 13 |
| December .. .. .. | 15 | 16 | 16 | 15 | 15 | 15 | 15 | 14 | 14 | 13 | 13 | 13 | 15 | 13 | 11 | 11 | 9 | 10 | 11 | 12 | 13 | 13 | 15 | 15 |
| Annual .. | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 13 | 13 | 13 | 14 | 14 | 13 | 12 | 12 | 12 | 11 | 10 | 11 | 12 | 12 | 12 | 13 | 13 |

# Appendix IV.

Kodaikánal Mean Hourly Bright Sunshine for the year 1907.

| Month. | Hours. 6-7 | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | 18-19 | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. | 0·13 | 0·75 | 0·85 | 0·88 | 0·85 | 0·89 | 0·87 | 0·85 | 0·71 | 0·62 | 0·51 | 0·10 | .. | |
| February .. | ·18 | ·92 | 1·00 | 1·00 | 1·00 | ·98 | ·96 | ·76 | ·72 | ·62 | ·53 | ·21 | .. | |
| March .. | ·3[illegible] | ·95 | ·98 | ·96 | ·94 | ·86 | ·69 | ·59 | 45 | ·37 | ·44 | ·35 | .. | |
| April .. .. | ·14 | ·70 | ·83 | ·87 | ·84 | ·81 | ·74 | ·63 | [illegible] | ·35 | 25 | ·09 | .. | |
| May .. .. | ·30 | ·76 | ·84 | ·93 | ·89 | ·89 | ·73 | ·61 | ·50 | ·45 | ·35 | ·14 | .. | |
| June .. .. | ·14 | ·45 | ·58 | ·56 | ·53 | ·46 | ·43 | ·41 | ·24 | ·26 | 26 | ·10 | .. | |
| July .. .. | ·11 | ·42 | ·48 | ·45 | ·45 | ·35 | ·25 | ·25 | ·26 | ·17 | ·06 | ·02 | .. | |
| August .. | ·06 | ·25 | ·37 | ·40 | ·38 | ·30 | ·23 | ·15 | ·08 | ·06 | ·03 | ·01 | .. | |
| September .. | ·05 | ·57 | ·72 | ·63 | ·59 | ·49 | ·36 | ·21 | ·22 | ·22 | ·20 | ·05 | .. | |
| October .. | .. | ·33 | ·66 | ·66 | ·54 | ·47 | ·32 | 30 | ·21 | ·29 | ·19 | ·03 | .. | |
| November .. | ·07 | ·36 | ·45 | ·59 | ·54 | ·45 | ·40 | ·39 | ·33 | ·31 | ·22 | ·01 | .. | |
| December .. | ·07 | ·54 | ·70 | ·77 | ·85 | ·81 | ·77 | ·77 | ·68 | ·61 | ·46 | ·03 | .. | |
| Mean .. | 0·13 | 0·58 | 0·70 | 0·72 | 0·70 | 0·65 | 0·56 | 0·49 | 0·40 | 0·36 | 0·29 | 0·10 | .. | |

# Appendix V.

Number of days in each month on which the Nilgiris were visible in 1907.

| Month. | Very clear. | Visible. | Just visible. | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January .. .. .. .. | .. | 11 | 4 | 3 | 18 |
| February .. .. .. .. | .. | 5 | 4 | 2 | 11 |
| March .. .. .. .. | .. | 1 | 5 | 1 | 7 |
| April .. .. .. .. | 2 | 2 | 10 | 1 | 15 |
| May .. .. .. .. .. | .. | .. | 1 | .. | 1 |
| June .. .. .. .. .. | 6 | 2 | 2 | .. | 10 |
| July .. .. .. .. .. | 3 | 3 | 4 | . | 10 |
| August .. .. .. . | 2 | 5 | .. | .. | 7 |
| September .. .. .. .. | 11 | 4 | 6 | .. | 21 |
| October .. .. .. .. | 4 | 1 | 5 | .. | 10 |
| November .. .. .. .. | 2 | 5 | 3 | 4 | 14 |
| December .. .. .. .. | 3 | 5 | 9 | 3 | 20 |
| Total .. | 33 | 44 | 53 | 14 | 144 |

Latitude—10° 9′ N.

Longitude—5h 10m 10s E.

# Appendix VI.

Height of barometer cistern above mean sea level 9,44 feet.

MEAN monthly and annual Meteorological Results at the Periyakulam Observatory in 1907.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer. Mean. | Dry bulb. Max. | Dry bulb. Min. | Dry bulb. Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. By Blanford's tables. | Relative humidity. By Blanford's tables. | Sun Max. in vac | Min. on grass. | Wind. Daily velocity. | Wind. Mean direction. | Wind. Mean direction. | Rain. Amount. | Rain. Days. | Clear sky. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | POINTS. | POINTS. | INCHES. | NO. | CENTS. |
| January .. .. .. | 29·001 | 0·141 | 74·6 | 86·7 | 63·8 | 22·9 | 66·4 | 61·6 | 0·540 | 63 | 134·7 | 57·2 | 38·7 | 13 | S.E. by S. | 0 80 | 2 | 64 |
| February .. .. .. | 28·987 | ·165 | 78·8 | 92·2 | 65·9 | 26·3 | 67·4 | 63·2 | ·517 | 53 | 141·0 | 57·4 | 51·2 | 10 | E.S.E. | .. | .. | 72 |
| March .. .. .. | ·949 | ·160 | 81·9 | 95·3 | 69·5 | 25·8 | 70·8 | 66·0 | ·614 | 56 | 147·7 | 63·6 | 74·0 | 14 | S.S.E. | 7·18 | 6 | 68 |
| April .. .. .. | ·898 | ·162 | 80·7 | 91·7 | 72·5 | 19·2 | 73·1 | 69·5 | ·714 | 68 | 146·8 | 68·8 | 48·9 | 17 | S. by W. | 11·95 | 11 | 44 |
| May .. .. .. | ·857 | ·133 | 82·7 | 96·5 | 73·0 | 23·5 | 73·0 | 69·2 | ·686 | 61 | 149·2 | 69·0 | 66·0 | 16 | S | 5·01 | 7 | 55 |
| June .. .. .. | ·820 | ·112 | 81·1 | 93·4 | 72·0 | 21·4 | 71·1 | 68·1 | 630 | 59 | 148·1 | 68·2 | 101·1 | 17 | S. by W. | 0·24 | .. | 37 |
| July .. .. .. | ·814 | ·110 | 80·4 | 92·7 | 71·4 | 21·3 | 71·3 | 68·3 | ·646 | 62 | 148·0 | 68·1 | 74·3 | 14 | S.S.E. | 2·72 | 6 | 31 |
| August .. .. .. | ·877 | ·114 | 79·0 | 90·1 | 71·1 | 19·0 | 70·2 | 65·8 | ·620 | 62 | 150·0 | 67·6 | 92·7 | 18 | S.S.W. | 1·52 | 2 | 25 |
| September .. .. .. | ·880 | ·140 | 81·4 | 94·6 | 71·4 | 23·2 | 70·6 | 67·2 | ·603 | 57 | 158·1 | 67·3 | 85·9 | 18 | S.S.W. | 1·93 | 4 | 46 |
| October .. .. .. | ·885 | ·141 | 79·2 | 88·7 | 72·3 | 16·4 | 71·9 | 68·9 | ·687 | 69 | 146·4 | 68·6 | 43·5 | 16 | S. | 7·00 | 9 | 34 |
| November .. .. .. | ·886 | 141 | 77·3 | 86·1 | 70·4 | 15·7 | 70·7 | 67·3 | 666 | 71 | 138·7 | 67·9 | 35·7 | 13 | S.E. by S. | 5·81 | 9 | 37 |
| December .. .. .. | ·890 | ·122 | 75·1 | 86·4 | 65·8 | 20·6 | 67·4 | 63·0 | ·572 | 65 | 139·8 | 61·7 | 32·2 | 12 | S.E. | 1·67 | 3 | 46 |
| Annual .. | 28·895 | 0·137 | 79·4 | 91·2 | 69·9 | 21·3 | 70·3 | 66·5 | 0·625 | 62 | 145·7 | 65·4 | 62·0 | 15 | S. by E. | 45·83 | 59 | 47 |

EXTREME monthly Meteorological Records at the Periyakulam Observatory in 1907.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry bulb thermometer. Highest. | | Dry bulb. Lowest. | | Wet bulb. Lowest. | | Humidity. Lowest. | | Sun. Th. in vacuo. Highest. | | Grass therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY. |
| January .. .. | 29·111 | 1 | 28·887 | 27 | 0·224 | 90·7 | 29 | 51·6 | 29 | 49·5 | 29 | 12 | 28 | 142·1 | 2 | 40·3 | 29 | 62·6 | 23 | 23·3 | 4 | 0·47 | 10 |
| February .. .. | ·131 | 9 | ·811 | 14 | ·320 | 95·9 | 24 | 58·6 | 13 | 56·4 | 13 | 21 | 21 | 146·3 | 28 | 48·0 | 13 | 87·5 | 11 | 21·9 | 1 | .. | .. |
| March .. .. | ·087 | 6 | ·777 | 14 | ·310 | 99·4 | 18 | 60·0 | 7 | 55·0 | 8 | 15 | 7 | 163·2 | 18 | 49·6 | 7 | 114·0 | 2 | 40·7 | 23 | 2·27 | 20 |
| April .. .. | ·054 | 4 | ·660 | 25 | ·394 | 96·0 | 25 | 65·5 | 1 | 62·7 | 1 | 30 | 24 | 157·8 | 28 | 62·9 | 4 | 83·7 | 5 | 22·7 | 19 | 2·31 | 11 |
| May .. .. | 28·982 | 18 | ·701 | 4 | ·281 | 99·2 | 3 | 66·8 | 21 | 65·2 | 21 | 21 | 6 | 154·9 | 7 | 62·9 | 21 | 122·1 | 16 | 16 8 | 9 | 1·74 | 22 |
| June .. .. | ·985 | 7 | ·661 | 15 | ·324 | 98·8 | 3 | 67·0 | 28 | 63·3 | 24 | 30 | 23 | 164·1 | 29 | 61·3 | 28 | 212·8 | 10 | 21·5 | 14 | 0·09 | 13 |
| July .. .. | ·953 | 10 | ·645 | 25 | ·308 | 97·3 | 5, 6 | 66·3 | 30 | 62·4 | 30 | 29 | 29 | 159·8 | 5 | 61·4 | 30 | 117·9 | 29 | 36·1 | 9 | 0·91 | 9 |
| August .. .. | ·990 | 26 | ·730 | 5 | ·260 | 94·5 | 27 | 66·7 | 27 | 64·0 | 27 | 38 | 15 | 163·5 | 27 | 62·7 | 27 | 160·1 | 1 | 37·1 | 8 | 0·93 | 5 |
| September .. .. | ·979 | 21 | ·740 | 9 | ·239 | 99·0 | 13 | 66·8 | 7 | 63·1 | 7 | 31 | 9 | 165·2 | 10 | 61·9 | 7 | 139·4 | 9 | 32·4 | 2 | 0·59 | 29 |
| October .. .. | ·985 | 25 | ·782 | 10 | ·203 | 92·8 | 17 | 74·4 | 2 | 61·1 | 28 | 54 | 28 | 157·3 | 19 | 63·0 | 15 | 73·7 | 18 | 5·5 | 30 | 1·47 | 9 |
| November .. .. | ·978 | 13 | ·786 | 2 | ·192 | 90·3 | 17 | 65·3 | 16 | 62·7 | 27 | 44 | 14 | 151 7 | 16 | 60·6 | 15 | 89·0 | 7 | 7·5 | 9 | 1·67 | 8 |
| December .. .. | ·977 | 6 | ·796 | 9,12 | ·181 | 90·9 | 10 | 58·1 | 28 | 55·4 | 28 | 31 | 30 | 148·3 | 18 | 50·9 | 28, 30 | 52·1 | 15 | 19·5 | 15 | 0·97 | 13 |

# Appendix VII.

MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1907.

| Abnormals of | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure .. .. .. | − 0·020 | − 0·005 | + 0·004 | + 0·020 | + 0·00[illegible] | − 0·017 | − 0·026 | − 0·006 | + 0·003 | + 0·003 | − 0·031 | − 0·028 | − 0·008 |
| Temperature of air .. .. .. .. .. | Same as | + 0·7 | + 1·1 | − 0·5 | + 1·8 | + 1·3 | + 1·0 | + 2·0 | + 1·6 | + 0·5 | + 0·2 | Same as | + 0·8 |
| Do. of evaporation .. .. .. | + 1·1 | + 1·4 | + 1·5 | + 0·4 | + 0·5 | + 0·5 | + 1·8 | + 1·0 | + 2·0 | + 1·0 | + 1·6 | + 0·5 | + 1·1 |
| Percentage of humidity .. .. .. .. | + 5 | + 4 | + 2 | + 4 | − 3 | − 2 | + 4 | − 3 | + 3 | + 3 | + 7 | + 3 | + 2 |
| Greatest solar heat in *vacuo* .. .. .. .. | − 5·8 | − 4·2 | − 2·2 | − 1·4 | − 1·2 | − 3·4 | − 5·5 | − 2·0 | − 1·3 | − 11·2 | − 12·4 | − 7·3 | − 4·8 |
| Maximum in shade .. .. .. .. .. | − 0·7 | − 0·4 | + 0·5 | − 0·5 | + 4·3 | + 1·8 | + 0·4 | + 3·2 | + 1·8 | − 0·4 | − 1·5 | − 0·8 | + 0·6 |
| Minimum in shade .. .. .. .. .. | − 0·6 | + 0·4 | + 1·3 | − 0·6 | Same as | + 1·2 | + 0·2 | + 1·4 | + 0·8 | + 0·1 | + 0·5 | − 0·4 | + 0·3 |
| Do. on grass .. .. .. .. .. | + 0·2 | + 0·9 | + 2·3 | Same as | + 0·3 | + 1·2 | + 1·1 | + 1·9 | + 1·7 | + 1·1 | + 2·0 | + 0·1 | + 1·1 |
| Rainfall in inches .. .. .. .. .. | − 0·78 | − 0·28 | − 0·39 | − 0·50 | − 2·12 | + 0·69 | − 1·07 | − 0·48 | − 4·40 | + 0·83 | + 2·95 | + 1·21 | .. |
| Do. since January .. .. .. .. | − 0·78 | − 1·06 | − 1·45 | − 1·95 | − 4·07 | − 3·38 | − 4·45 | − 4·93 | − 9·33 | − 8·50 | − 5·55 | − 4·34 | − 4·34 |
| General direction of wind .. .. .. .. | Same as | 1 point S. | 2 points E. | 1 point E. | Same as | 1 point W. | Same as | 2 points W. | 2 points S. | 2 points N. | 2 points E. | 1 point N. | 1 point E. |
| Daily velocity in miles .. .. .. .. | − 7 | − 3 | + 6 | − 35 | − 46 | − 28 | − 20 | + 12 | − 15 | − 3 | + 2 | − 22 | − 13 |
| Percentage of cloudy sky .. .. .. .. | − 14 | − 4 | − 1 | + 6 | − 10 | − 8 | − 12 | − 3 | − 16 | − 8 | + 3 | − 13 | − 7 |
| Do. of bright sunshine .. .. .. | − 7·7 | − 15·9 | − 8·7 | − 3·9 | − 9·8 | − 14·9 | + 0·9 | − 10·5 | + 4·3 | − 7·2 | − 16·5 | − 7·4 | − 7·7 |

+ means *above* normal , − *below*.

# Appendix VIII.

ABSTRACT of the mean meteorological condition of Madras in the year 1907 compared with the average of past years.

| Mean values of | 1907. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure .. .. .. .. .. .. | 29·856 | 0·008 below. | 29·864 |
| Temperature of air .. .. .. .. .. . .. | 81·9 | 0·8 above. | 81·1 |
| Do. of evaporation .. .. .. .. .. .. | 75·6 | 1·1 ,, | 74·5 |
| Percentage of humidity .. .. . .. .. .. | 74 | 2 ,, | 72 |
| Greatest solar heat in *vacuo* .. .. .. .. .. .. | 134·9 | 4·8 below | 139·7 |
| Maximum in shade . .. .. .. .. .. .. | 91·4 | 0·6 above. | 90·8 |
| Minimum in shade .. .. .. .. .. .. .. | 75·0 | 0·3 ,, | 74·7 |
| Do. on grass .. .. .. .. .. .. .. | 73·0 | 1·1 ,, | 71·9 |
| Rainfall in inches on 88 days .. .. .. .. .. .. | 44·68 | 4·34 below. | 49·02 |
| General direction of wind .. .. .. .. .. .. | S.E. by E. | 1 point E. | S.E. |
| Daily velocity in miles .. .. .. .. .. .. .. | 158 | 13 below. | 171 |
| Percentage of cloudy sky .. .. .. .. .. .. | 42 | 7 ,, | 49 |
| Do. of bright sunshine .. .. .. .. .. .. | 50·7 | 7 7 ,, | 58·4 |

DURATION and quantity of the wind from different points.

| From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North .. | 248 | 1,610 | East .. | 271 | 1,420 | South . | 106 | 826 | West .. | 310 | 2,813 |
| N. by E. .. | 190 | 1,261 | E. by S. .. | 339 | 1,738 | S. by W. .. | 155 | 1,089 | W. by N... | 255 | 2,304 |
| N.N.E. .. | 353 | 2,227 | E.S.E. .. | 386 | 1,887 | S.S.W. .. | 148 | 1,026 | W.N.W. .. | 105 | 937 |
| N.E. by N... | 488 | 3,273 | S.E. by E. | 619 | 3,542 | S.W. by S. | 173 | 1,225 | N.W. by W. | 90 | 542 |
| N.E. .. | 342 | 2,268 | S.E. .. | 756 | 4,755 | S.W. .. | 165 | 1,146 | N.W. .. | 66 | 403 |
| N.E. by E. | 258 | 1,673 | S.E. by S. | 543 | 4.215 | S.W. by W. | 197 | 1,352 | N.W. by N. | 120 | 786 |
| E.N.E. .. | 228 | 1,310 | S.S.E. .. | 229 | 1,727 | W.S.W. .. | 284 | 1,843 | N.N.W. .. | 114 | 860 |
| E. by N. .. | 406 | 2,234 | S. by E. .. | 126 | 1,027 | W. by S. .. | 395 | 3,234 | N. by W... | 179 | 1,199 |

There were 116 calm hours during the year. The resultant corresponding to the above numbers is represented by a E.S.E. wind, blowing with a uniform daily velocity of 24 miles.

# Appendix IX.

Madras Observatory.—Number of hours of wind from each point in the year 1907.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. .. .. | .. | 7 | 43 | 259 | 145 | 35 | 6 | 24 | 65 | 41 | 70 | 110 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 9 |
| February .. .. .. .. | .. | .. | .. | .. | 1 | 38 | 85 | 142 | 73 | 55 | 29 | 65 | 111 | 46 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 13 |
| March .. .. .. | .. | 7 | .. | 2 | 16 | 54 | 40 | 145 | 10 | 29 | 42 | 26 | 205 | 107 | 21 | 9 | 4 | 7 | 8 | 6 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 6 |
| April .. .. .. .. | .. | 1 | .. | .. | .. | 3 | 7 | 14 | 1 | 51 | 56 | 204 | 113 | 149 | 17 | 8 | 5 | 10 | 9 | 10 | 4 | 1 | 12 | 2 | 2 | 3 | 1 | 1 | 1 | 12 | 2 | 3 | 18 |
| May .. .. .. .. | 2 | .. | .. | .. | .. | 2 | 1 | 6 | 28 | 34 | 29 | 85 | 115 | 79 | 41 | 35 | 42 | 56 | 28 | 36 | 20 | 19 | 18 | 11 | 17 | 9 | 9 | 5 | 1 | 2 | 1 | .. | 13 |
| June .. .. .. .. | 4 | 2 | .. | 6 | 8 | 3 | 2 | 4 | 4 | 8 | 12 | 22 | 29 | 34 | 29 | 24 | 19 | 38 | 19 | 11 | 30 | 40 | 46 | 84 | 88 | 81 | 27 | 17 | 10 | 8 | 2 | 4 | 5 |
| July .. .. .. .. | 10 | 1 | 1 | 3 | 1 | 1 | 8 | 2 | 3 | 12 | 14 | 13 | 73 | 46 | 28 | 11 | 7 | 17 | 27 | 34 | 53 | 56 | 89 | 93 | 48 | 32 | 13 | 9 | 8 | 4 | 8 | 14 | 5 |
| August .. .. .. .. | 2 | .. | 1 | .. | .. | 1 | 1 | 2 | 2 | 8 | 2 | 16 | 18 | 24 | 10 | 20 | 14 | 13 | 30 | 45 | 26 | 57 | 70 | 163 | 102 | 67 | 12 | 18 | 6 | 7 | 3 | 3 | 1 |
| September .. .. .. .. | 2 | 2 | 16 | .. | 2 | 4 | 4 | 3 | 12 | 54 | 97 | 104 | 52 | 33 | 21 | 9 | 8 | 7 | 17 | 15 | 23 | 22 | 34 | 31 | 16 | 39 | 21 | 15 | 15 | 21 | 7 | 4 | 10 |
| October .. .. .. .. | 44 | 57 | 83 | 99 | 16 | 44 | 10 | 23 | 11 | 30 | 16 | 20 | 2 | 24 | 58 | 6 | 4 | 5 | 5 | 8 | 5 | 1 | 1 | 4 | 4 | 6 | 5 | 19 | 18 | 39 | 34 | 27 | 16 |
| November .. .. .. .. | 30 | 29 | 79 | 60 | 73 | 55 | 37 | 27 | 50 | 17 | 19 | 24 | 38 | 1 | 2 | 1 | 1 | 1 | 4 | 6 | 2 | .. | 14 | 7 | 33 | 18 | 17 | 6 | 7 | 12 | 17 | 20 | 13 |
| December .. .. .. .. | 154 | 84 | 130 | 59 | 80 | 18 | 27 | 14 | 12 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 15 | 40 | 104 | 7 |
| Annual .. | 248 | 190 | 353 | 488 | 342 | 258 | 228 | 406 | 271 | 339 | 386 | 619 | 756 | 543 | 229 | 126 | 106 | 155 | 148 | 173 | 165 | 197 | 284 | 395 | 310 | 255 | 105 | 90 | 66 | 120 | 114 | 179 | 116 |

# Appendix X.

MADRAS OBSERVATORY.—Number of miles of wind from each point in the year 1907.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. .. .. | .. | 88 | 280 | 1823 | 987 | 166 | 40 | 81 | 222 | 154 | 230 | 188 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 4259 |
| February .. .. .. .. | .. | .. | .. | .. | 10 | 165 | 464 | 750 | 355 | 228 | 155 | 293 | 550 | 251 | 16 | 24 | 12 | 8 | 6 | 13 | 14 | 4 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3318 |
| March .. .. .. .. .. | .. | 88 | .. | 24 | 45 | 309 | 172 | 770 | 88 | 203 | 160 | 159 | 1392 | 931 | 193 | 92 | 56 | 71 | 84 | 60 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 4897 |
| April .. . .. .. .. | .. | 12 | .. | .. | .. | 31 | 64 | 67 | 10 | 284 | 332 | 1325 | 759 | 1171 | 103 | 60 | 44 | 76 | 63 | 60 | 23 | 6 | 44 | 11 | 11 | 23 | 7 | 5 | 5 | 49 | 4 | 24 | 4673 |
| May .. .. .. .. .. | 18 | . | .. | .. | .. | 13 | 10 | 53 | 179 | 159 | 173 | 456 | 804 | 727 | 467 | 316 | 364 | 401 | 216 | 298 | 171 | 163 | 143 | 84 | 141 | 79 | 92 | 47 | 12 | 14 | 6 | .. | 5606 |
| June .. .. .. .. .. | 10 | 18 | .. | 45 | 62 | 31 | 18 | 33 | 30 | 62 | 103 | 189 | 220 | 318 | 273 | 202 | 124 | 256 | 150 | 77 | 233 | 252 | 313 | 693 | 907 | 727 | 241 | 89 | 34 | 38 | 13 | 6 | 5767 |
| July .. .. .. .. .. | 43 | 8 | 6 | 21 | 2 | 5 | 58 | 18 | 28 | 70 | 99 | 94 | 527 | 351 | 207 | 69 | 46 | 106 | 142 | 216 | 355 | 432 | 659 | 852 | 450 | 329 | 112 | 56 | 25 | 24 | 40 | 62 | 5512 |
| August .. .. .. . | 15 | .. | 8 | .. | .. | 3 | 13 | 3 | 28 | 73 | 14 | 147 | 160 | 206 | 71 | 157 | 85 | 70 | 187 | 282 | 167 | 363 | 460 | 1310 | 1004 | 658 | 102 | 88 | 28 | 28 | 20 | 14 | 5764 |
| September .. .. .. .. | 14 | 15 | 53 | .. | 17 | 33 | 36 | 27 | 84 | 286 | 487 | 538 | 228 | 201 | 145 | 65 | 57 | 63 | 121 | 113 | 145 | 129 | 165 | 209 | 143 | 279 | 208 | 119 | 83 | 107 | 51 | 16 | 4237 |
| October .. .. .. .. | 177 | 265 | 391 | 497 | 131 | 254 | 88 | 131 | 71 | 132 | 51 | 51 | 13 | 54 | 238 | 37 | 32 | 31 | 28 | 40 | 20 | 3 | 7 | 30 | 26 | 22 | 24 | 57 | 122 | 281 | 209 | 214 | 3727 |
| November .. .. .. .. | 252 | 230 | 602 | 438 | 534 | 498 | 218 | 223 | 241 | 87 | 83 | 102 | 102 | 5 | 14 | 5 | 6 | 7 | 29 | 66 | 18 | .. | 52 | 45 | 131 | 187 | 151 | 81 | 94 | 176 | 171 | 147 | 4995 |
| December .. . .. .. | 1081 | 537 | 887 | 425 | 480 | 165 | 129 | 78 | 84 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 69 | 346 | 716 | 4997 |
| Annual .. | 1610 | 1261 | 2227 | 3273 | 2268 | 1673 | 1310 | 2234 | 1420 | 1738 | 1887 | 3542 | 4755 | 4215 | 1727 | 1027 | 826 | 1089 | 1026 | 1225 | 1146 | 1352 | 1843 | 3234 | 2813 | 2304 | 937 | 542 | 403 | 786 | 860 | 1199 | 57752 |

# Appendix XI.

MADRAS OBSERVATORY.—Number of inches of rain from each point in the year 1907.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. .. | .. | .. | .. | 0·11 | | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | . | .. | .. | .. |
| February .. . .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | . | | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| March .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| April .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | | .. | .. | . | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·10 | . | 0·02 | .. |
| May .. . .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | . | .. | .. | . | .. | .. |
| June .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·05 | .. | 0·01 | 0· 1 | | 0·11 | 0·15 | 0·12 | 0·02 | .. | 0·71 | 0·05 | 0·05 | . | .. | 0·05 | 0·03 | 0·22 | .. | 0·10 | . | .. | 0·02 |
| July .. .. .. | 0·09 | .. | .. | .. | .. | 0·13 | .. | .. | .. | 0·01 | .. | 0·03 | | .. | . | . | .. | 0 08 | .. | ·023 | 0·03 | 0·01 | 0·53 | 1·18 | 0·02 | 0·02 | .. | .. | 0·02 | 0·09 | 0·31 | 0·02 | .. |
| August .. .. .. | 0·06 | .. | 0·01 | .. | .. | . | .. | .. | .. | 0 09 | .. | 0·03 | 0·06 | .. | .. | 0 02 | .. | 0·11 | 0·52 | 0·40 | 0·66 | 0·98 | 0 06 | 0·06 | 0·06 | 0·10 | .. | 0·14 | 0·15 | .. | . | 0·57 | .. |
| September .. .. | 0·03 | . | 0 01 | .. | .. | .. | 0·06 | .. | 0·04 | .. | .. | 0·03 | .. | .. | .. | .. | .. | .. | 0·02 | 0·01 | 0·01 | .. | .. | .. | .. | .. | .. | 0·05 | 0·02 | 0·01 | .. | .. | .. |
| October .. .. .. | 1·72 | 0·63 | 0·87 | 0·45 | 0·08 | 0·04 | 0·16 | 0·16 | 0·04 | 1·12 | .. | .. | .. | .. | .. | .. | .. | .. | . | .. | .. | .. | . | .. | 0·12 | . | 1·23 | 0·05 | 1·37 | 1·61 | 0·35 | 1·83 | .. |
| November .. .. | 0·09 | 1·79 | 0·77 | 0·27 | 1·01 | 0·11 | 0·15 | 1·19 | 0·18 | 1·15 | 0·56 | .. | 0·05 | .. | . | .. | .. | 0·01 | 0·47 | 0·60 | 0·03 | .. | 0·56 | 0·02 | 0·02 | 1·45 | 1·43 | 0·05 | 2·53 | 0·95 | 0·13 | 0·59 | .. |
| December .. .. | 0·76 | 0·28 | 0·03 | 0·79 | 1·21 | 0·11 | 0·55 | 0·95 | 1·18 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | | .. | .. | .. | . | .. | .. | .. | | 0·01 | 0·52 | 0·10 | .. |
| Annual .. | 2·75 | 2·70 | 1·69 | 1·62 | 2·30 | 0·39 | 0·92 | 2·30 | 1·44 | 2·37 | 0·61 | 0 09 | 0·12 | 0·11 | | 0·13 | 0·15 | 0·32 | 1·03 | 1·24 | 1·44 | 1·04 | 1·20 | 1·26 | 0·22 | 1·62 | 2·69 | 0·51 | 4·09 | 3·87 | 1·31 | 3·13 | 0·02 |

# Appendix XII.

MADRAS OBSERVATORY.—Wind, cloud, and bright sunshine, 1907.

| Month. | Wind resultant. | | Clouds (0—10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H. | 16 H. | 20 H. | Mean. | Average per day. | Greatest number of hours in a day. |
| | MILES. | | | | | | | HOURS. | |
| January .. .. .. .. | 121 | N.E. | 2·6 | 2·8 | 2·2 | 1·2 | 2·3 | 7·6 | 9·1 |
| February .. .. .. | 101 | E. by S. | 1·6 | 3·0 | 2·0 | 1·2 | 2·0 | 8·9 | 10·0 |
| March .. .. .. .. | 124 | S.E. by E. | 2·8 | 3·8 | 1·6 | 1·2 | 2·3 | 8·4 | 10·5 |
| April .. .. .. .. | 133 | S.E. by E. | 4·2 | 4·1 | 3·1 | 2·0 | 3·4 | 8·5 | 11·0 |
| May .. .. .. .. | 121 | S. by E. | 2·9 | 2·5 | 3·5 | 2·0 | 2·8 | 7·3 | 9·0 |
| June .. .. .. .. | 100 | S.W. by W. | 5·3 | 5·2 | 6·6 | 5·3 | 5·6 | 4·1 | 7·3 |
| July .. .. .. .. | 97 | S.W. | 6·5 | 6·3 | 6·0 | 4·9 | 5·9 | 4·3 | 8·2 |
| August .. .. .. | 130 | W.S.W. | 5·9 | 5·3 | 7·7 | 6·5 | 6·4 | 3·8 | 8·0 |
| September .. .. | 38 | S. by E. | 5·0 | 4·7 | 5·6 | 3·0 | 4·6 | 5·9 | 10·6 |
| October . .. .. .. | 63 | N.N.E. | 4·7 | 5·5 | 6·4 | 4·1 | 5·1 | 5·3 | 10·2 |
| November .. .. .. | 96 | N.N.E. | 6·6 | 6·5 | 6·3 | 5·3 | 6·2 | 4·1 | 8·5 |
| December .. .. .. | 144 | N. by E. | 4·2 | 4·4 | 3·8 | 3·2 | 3·9 | 5·6 | 8·2 |
| Annual .. | 24 | E.S.E. | 4·4 | 4·5 | 4·6 | 3·3 | 4·2 | 6·2 | 9·2 |

# Appendix XIII.

MEAN monthly and annual Meteorological Results at the Madras Observatory in 1907.

| | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer. Mean. | Dry bulb thermometer. Max. | Dry bulb thermometer. Min. | Dry bulb thermometer. Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. By Blanford's tables. | Relative humidity. By Blanford's tables. | Sun Max. *in vac.* | Min. on grass. | Wind. Daily velocity. | Wind. Mean direction. | | Rain. Amount. | Rain. Days. | Cloudy sky. | Bright sunshine. | Dew point. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | PTS. | | INCHES. | NO. | CENTS. | HOURS. | ° |
| January .. .. .. | 29·977 | 0·115 | 75·1 | 83·9 | 66·9 | 17·1 | 70·3 | 66·3 | 0·680 | 78 | 132 6 | 63·3 | 137 | 5 | N.E. by E. | 0·11 | 3 | 23 | 234·4 | 66·6 |
| February .. .. .. | ·959 | ·121 | 77·4 | 86·2 | 68·4 | 17·8 | 72·2 | 68·1 | ·724 | 77 | 135·5 | 64·7 | 119 | 9 | E. by. S. | . | .. | 20 | 249·2 | 68·6 |
| March .. .. .. | ·909 | ·128 | 81·1 | 89·7 | 73·4 | 16·3 | 75·4 | 72·4 | ·808 | 76 | 138·3 | 70·9 | 158 | 10 | E. S. E. | .. | .. | 23 | 261·1 | 71·5 |
| April .. .. .. | ·845 | ·132 | 83·5 | 92·4 | 76·6 | 15·9 | 78·0 | 75·2 | ·889 | 78 | 140·3 | 74·7 | 156 | 12 | S. E. | 0·12 | 2 | 34 | 255·3 | 74·4 |
| May .. .. .. | ·740 | ·118 | 88·5 | 102·1 | 80·8 | 21·3 | 78·8 | 75·2 | ·856 | 64 | 141·8 | 79·2 | 181 | 15 | S. by [illegible] | .. | .. | 28 | 226·4 | 72·7 |
| June .. .. .. | ·686 | ·121 | 87·7 | 100·1 | 81·5 | 18·7 | 77·1 | 73·8 | ·788 | 60 | 137·1 | 79·8 | 192 | 20 | S. W. | 2·80 | 9 | 56 | 121·9 | 69·7 |
| July .. .. .. | ·695 | ·119 | 85·5 | 96·0 | 78·7 | 17·3 | 77·7 | 74·7 | ·845 | 69 | 133·2 | 77·7 | 178 | 20 | S. W. | 2·80 | 11 | 59 | 132·0 | 73·6 |
| August .. .. .. | ·744 | ·130 | 85·3 | 96·9 | 78·7 | 18·2 | 77·0 | 73·8 | ·816 | 67 | 138·0 | 77·3 | 186 | 21 | S.W. by W. | 4·08 | 19 | 64 | 118·1 | 71·5 |
| September .. .. .. | ·781 | ·130 | 84·6 | 95·0 | 77·9 | 17·2 | 78·3 | 75·0 | ·885 | 75 | 140·0 | 76·7 | 141 | 16 | S. | 0·29 | 6 | 46 | 175·7 | 74·1 |
| October .. .. .. | ·845 | ·117 | 81·1 | 88·6 | 75·3 | 13·3 | 76·6 | 74·2 | ·859 | 81 | 127·9 | 73·9 | 120 | 5 | N.E. by E. | 11·88 | 16 | 51 | 164·1 | 73·4 |
| November .. .. .. | ·893 | ·105 | 77·7 | 83·5 | 72·8 | 10·7 | 74·5 | 72·0 | ·815 | 86 | 125·0 | 71·5 | 167 | 4 | N.E. | 16·16 | 15 | 62 | 122·1 | 72·3 |
| December .. .. .. | ·950 | ·110 | 75·5 | 82·8 | 69·4 | 13·4 | 71·1 | 68·2 | ·709 | 80 | 128·5 | 66·5 | 161 | 1 | N. by E. | 6·49 | 7 | 39 | 174·3 | 68·0 |
| Annual .. | 29·835 | 0·121 | 81·9 | 91·4 | 75·0 | 16·4 | 75·6 | 72·4 | 0·806 | 74 | 134·9 | 73·0 | 158 | 11 | S. E. by E. | 44·68 | 88 | 42 | 2,234·6 | 71·4 |

EXTREME monthly Meteorological Records at the Madras Observatory in 1907.

| | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry bulb thermometer. Highest. | | Dry bulb thermometer. Lowest. | | Wet bulb. Lowest. | | Humidity. Lowest. | | Sun Th. *in vacuo.* Highest. | | Grass therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES | DAY. |
| January .. .. .. | 30·080 | 1 | 29·869 | 27 | 0·211 | 86·5 | 29 | 59·6 | 31 | 59·5 | 31 | 57 | 19, 23, 25 | 137·3 | 13 | 55·2 | 31 | 230 | 12 | 62 | | 0·07 | 1 |
| February .. .. .. | ·094 | 9 | ·806 | 14 | ·288 | 91·2 | 24 | 63·6 | 13 | 63·4 | 13 | 56 | 3 | 142·0 | 24 | 59·1 | 13 | 171 | 5 | 71 | | .. | .. |
| March .. .. .. | ·031 | 5 | ·720 | 13 | ·311 | 95·1 | 23 | 66·2 | 4 | 65·4 | 4 | 46 | 26 | 144·5 | 24 | 62·1 | 4 | 259 | 24 | 76 | 6 | .. | .. |
| April .. .. .. | 29·991 | 3 | ·662 | 30 | ·329 | 97·4 | 30 | 71·6 | 12 | 70·8 | 12 | 55 | 28 | 147·0 | 28 | 69·6 | 1 | 218 | 25 | 106 | 19 | 0·10 | 12 |
| May .. .. .. | ·857 | 13 | ·591 | 3 | ·266 | 109·0 | 24 | 76·3 | 1 | 71·5 | 19 | 33 | 3 | 146·3 | 4 | 72·6 | 10 | 286 | 30 | 115 | 1 | .. | .. |
| June .. .. .. | ·858 | 20 | ·526 | 15 | ·332 | 107·6 | 1 | 74·9 | 14 | 71·6 | 24 | 31 | 23 | 148·6 | 21 | 73·1 | 15 | 254 | 26 | 123 | 15 | 1·38 | 13 |
| July .. .. .. | ·848 | 10 | ·515 | 25 | ·333 | 100·8 | 14 | 75·0 | 9 | 71·9 | 31 | 36 | 27 | 143·5 | 13 | 72·8 | 9 | 237 | 27 | 133 | 21 | 1·20 | 17 |
| August .. .. .. | ·852 | 26 | ·585 | 6 | ·267 | 101·0 | 20 | 73·6 | 11 | 71·1 | 16 | 37 | 16 | 151·2 | 27 | 72·4 | 7 | 241 | 13 | 111 | 11 | 1·08 | 30 |
| September .. .. .. | ·918 | 24 | ·633 | 9 | ·285 | 100·6 | 10 | 72·6 | 1, 24 | 72·0 | 10 | 42 | 11 | 149·7 | 16 | 74 0 | 1, 11, 25 | 191 | 9 | 90 | 13 | 0·12 | 6 |
| October .. .. .. | 30·001 | 28 | ·669 | 16 | ·332 | 99·3 | 15 | 71·4 | 14 | 70·6 | 15 | 29 | 15 | 145·4 | 16 | 68·9 | 14 | 182 | 18 | 68 | 20 | 5.06 | 2 |
| November .. .. .. | ·024 | 19 | ·651 | 26 | ·373 | 87·4 | 5 | 65·8 | 14 | 63·9 | 14 | 62 | 10 | 138·8 | 2 | 64·9 | 14 | 316 | 26 | 70 | 19 | 3·64 | 13 |
| December .. .. .. | ·098 | 29 | ·812 | 8 | ·286 | 86·8 | 9 | 61·8 | 5 | 60·7 | 5 | 47 | 3 | 140·6 | 18 | 58·0 | 5 | 295 | 14 | 107 | 17 | 3·27 | 14 |

# KODAIKÁNAL AND MADRAS OBSERVATORIES.

## REPORT FOR THE YEAR 1908.

CONTENTS.

# KODAIKÁNAL AND MADRAS OBSERVATORIES.

## I.—REPORT OF THE KODAIKÁNAL OBSERVATORY FOR THE YEAR 1908.

1. **Staff.**—The staff of the Observatory on the 31st December 1908 was as follows :—

| | |
|---|---|
| Director .. .. .. .. | C. Michie Smith, B.Sc. |
| Assistant Director .. .. .. | J. Evershed. |
| First Assistant .. .. .. | K. V. Sivarama Aiyar, M.A. (*on leave*). |
| Second Assistant (Acting First Assistant). .. | S. Sitarama Aiyar, B.A. |
| Third Assistant (Acting Second Assistant) .. | G. Nagaraja Aiyar. |
| Acting Third Assistant .. .. | A. Y. Subrahmanya Aiyar, B.A. |
| Fourth Assistant .. .. .. | S. Balasundaram Aiyar. |
| Writer .. .. .. .. | L. N. Krishnaswami Aiyar. |
| Photographic Assistant .. .. | R. Krishna Aiyar. |

The Director returned from furlough and took charge on January 2. The first assistant went, on July 20, on combined privilege leave and leave on medical certificate for 6 months and 23 days. The second and third assistants are acting as first and second assistants respectively, while the post of third assistant has been filled by A. Y. Subrahmanya Aiyar, B.A. The acting first assistant was on privilege leave for 41 days from September 21 and the acting second assistant is on two months' privilege leave from November 11.

The subordinate staff consists of a book-binder, a book-binder's boy, a mechanic, five peons, a boy peon for the dark room, and two lascars.

2. **Distribution of work.**—The Director is in charge of the 40-foot spectrograph and the pyrheliometer; the Assistant Director is in charge of the spectroheliograph and associated instruments. The first, second, and third assistants are in charge of the work with the Cooke equatorial (spectroscopic), the Lerebour and Secretan equatorial (visual), the photoheliograph, the transit instrument, and the seismometer They have also to do the astronomical computing and the preparation of the observations for the press. The fourth assistant has charge of the clock comparisons and, with the help of the writer, is responsible for the whole of the meteorological work. The writer is responsible for the accounts, correspondence, and all office records. The photographic assistant has charge of most of the photographic developing, printing, etc.

3. **Buildings and grounds**—(*a*) *Spectroheliograph building.*—The roof of this building has given some trouble from leaking and it has been resolved to cover it with ruberoid. Part of the work had been done by the close of the year. The moving roof has now been fitted up with winches by which it is easily opened and closed by one man.

(*b*) The aeromotor having been repaired was re-erected in August and has worked well.

(*c*) The new flagstaff referred to in the last report was erected in April.

(*d*) The grounds have been maintained in fair order during the year but some damage was done to them by a grass fire in February. The fire came from outside, driven by a strong wind, and though the fire lines were in good order and every

available man was employed in fighting it, it leaped the fire line and spread rapidly over some 50 acres of the compound. Fortunately it was possible to save the greater part of the plantations so that the actual damage done was not great. This year the fire lines have been widened in parts and some new lines are being cut. The fire swept close past the spectroheliograph house on the east side leaving a large area of blackened soil close at hand. The effect of this on the steadiness of the solar image was very marked and the time of best seeing in the morning was greatly reduced. Some showers of rain fell a few days after the fire, and within three weeks the grass had sprung up thickly and normal conditions were nearly restored.

4. **Instruments.**—The following are the principal instruments belonging to the Observatory or in use at the present time :—

Six-inch Cooke equatorial.
Six-inch Lerebour and Secretan equatorial remounted by Grubb with a five-inch Grubb portrait lens of 36 inches focus attached.
Spectrograph I—consisting of slit, collimator lens of 4 or 7 feet focus, 2-inch parabolic grating, and camera tube without lens. Used in connection with an 11-inch polar siderostat and 6-inch Grubb lens of 40 feet focus.
A rhomb with ends cut at 45° mounted on a graduated circle can be placed in front of the slit so as to enable any part of the limb to be brought on to the slit.
Spectrograph II—consisting of slit, collimator lens of 3 feet focus, 3-inch plane grating and camera lens of 7 feet focus. Used in connection with the 12-inch photo-visual lens of the spectroheliograph.
Spectroheliograph—with 18-inch siderostat and 12-inch Cooke photo-visual lens of 20 feet focus, by the Cambridge Scientific Instrument Company.
An auxiliary spectroheliograph attached to the above, made in the Observatory workshop.
Six-inch transit instrument and barrel chronograph, formerly the property of the Survey of India.
Six-prism table spectroscope—Hilger.
Photoheliograph Dallmeyer No. 4.
Theodolite, six-inch—Cooke.
Two phototheodolites by Steinheil, for cloud photography.
Sextant.
Evershed spectroscope with three prisms for prominence and sunspot work, by Hilger.
Mean time clock, Kullberg 6326.
Do. Shelton.
Mean time Chronometer 6299.
Sidereal chronometer, Kullberg 6134
Tape chronograph, Fuess.
Micrometer for measuring spectrum photographs, Hilger.
Dividing engine, Cambridge Scientific Instrument Company, Limited.
Two Balfour Stewart actinometers.
Buchanan's solar calorimeter.
Induction coil with necessary adjuncts.
Small polar siderostat.
Universal instrument.
Complete set of meteorological instruments, including Richard barograph and thermograph, and wind recorders.
A high class screw cutting turning lathe by Messrs. Cooke & Sons.
Ångström Pyrheliometer.

An 18-inch concave mirror by Henry of Paris belonging to the Assistant Director has been mounted in the spectroheliograph room for general spectrum work and for large scale photographs of sunspots.

## OBSERVATIONS.

### (*a*) Solar Physics.

5. The following table shows for each day the solar observations that were made. The number of days on which observations were possible under each head was nearly the same as in the previous year. The most striking divergence from normal was the exceptionally fine weather in November, when visual prominence observations were possible on 27 days. There were 20 days in the year on which no solar observations were possible.

# Table A.

## Solar Observations in 1908.

A = Spots observed. B = Spot spectra. C = Prominences. D = Photoheliograms. E = Spectroheliograms.

| Date. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 .. | A—*C*DE | ABCDE | A—*C*DE | A—CDE | ABCDE | ABCDE | A——DE | — | A—CDE | ABCDE | — | — |
| 2 .. | ——D— | ABCDE | A—*C*DE | A—CDE | A—*C*DE | ABCDE | ABCDE | ——*E* | ABCDE | A—CDE | — | A—CDE |
| 3 .. | A—*C*D*E* | ABCDE | A—CDE | A—CDE | ABCDE | A——D*E* | A—*C*D*E* | A—*C*DE | — | ABCDE | — | AB*C*DE |
| 4 .. | A—CDE | A—CDE | A—CDE | A—CDE | ABCDE | A—*C*DE | A——DE | A——D*E* | A——D*E* | A———*E* | A—*C*D*E* | A—CDE |
| 5 .. | A—CDE | A—*C*DE | A—CDE | A—*C*DE | ABCDE | ABCDE | A——D*E* | AB*C*DE | A—CD*E* | ABCDE | A—CDE | AB*C*DE |
| 6 .. | — | A—CDE | A—*C*DE | ABCDE | A—*C*D*E* | ABCDE | A—CDE | A——— | ABCDE | A—CDE | ABCDE | ABCDE |
| 7 .. | A—*C*DE | A—CDE | A—CDE | A—*C*DE | ABCDE | ABCDE | A—*C*DE | A——D*E* | A—*C*D— | A—*C*D*E* | ABCDE | ABCDE |
| 8 .. | ABCDE | A—CDE | A—*C*DE | AB*C*DE | A—CDE | A—*C*DE | A——DE | A——DE | A—*C*DE | A—*C*DE | ABCDE | ABCDE |
| 9 . | ABCDE | A—CDE | A—*C*DE | AB*C*DE | A—*C*DE | A—*C*DE | A—CDE | A—*C*DE | A—*C*D*E* | A—CDE | A—CDE | ABCDE |
| 10 .. | ABCDE | A—CDE | A—CDE | A—*C*DE | A—CDE | A—*C*DE | A——D*E* | A—CDE | A—*C*D*E* | A—*C*DE | ABCDE | ABCDE |
| 11 .. | A—*C*DE | A—*C*DE | A—CDE | A—*C*DE | A—*C*DE | — | — | A—*C*DE | A——D*E* | A—CDE | AB*C*DE | ABCDE |
| 12 .. | ABCDE | A—*C*DE | A—CDE | ABCDE | A—*C*DE | A—*C*D*E* | — | A—*C*DE | AB*C*DE | A—CDE | ABCDE | ABCDE |
| 13 .. | ABCDE | A—CDE | A—CDE | ABCDE | A—CDE | A——— | A——D*E* | A—CDE | A—CDE | A—CDE | AB*C*DE | A—*C*DE |
| 14 .. | A—*C*DE | A—*C*D*E* | A—CDE | ABCDE | A—*C*DE | A—*C*DE | A——D*E* | A—*C*DE | AB*C*DE | A—CD*E* | A—*C*DE | A—CDE |
| 15 .. | A—*C*DE | A—CDE | A—CDE | ABCDE | ABCDE | A—CDE | A—CDE | ABCDE | ABCDE | A—*C*DE | ABCDE | A—*C*DE |
| 16 .. | A——*E* | A—CDE | A—CDE | A—CDE | ABCDE | A—CDE | AB*C*DE | ABCDE | A—*C*DE | A——D*E* | A—*C*DE | A—*C*DE |
| 17 .. | A—*C*DE | A—*C*DE | A—CDE | ABCDE | A—CDE | A—CDE | A—*C*DE | A—*C*DE | A—*C*DE | A—*C*DE | A—CDE | A—*C*DE |
| 18 .. | A—CDE | A—CDE | A—CDE | ABCDE | ABCDE | A—*C*DE | A——DE | ABCDE | A—*C*DE | A—CDE | A—CDE | A—CDE |
| 19 .. | A—*C*DE | A—CDE | A—CDE | ABCDE | A—CDE | A—CDE | — | A—*C*DE | A—*C*DE | A—*C*DE | ABCDE | A—CDE |
| 20 .. | ABCDE | A—CDE | ABCDE | ABCDE | AB*C*DE | A—CDE | A——D*E* | A—CDE | ABCDE | A—*C*DE | AB*C*DE | A—CDE |
| 21 .. | ABCDE | A—*C*D*E* | A—*C*DE | ABCDE | A—*C*DE | A—*C*DE | A——D*E* | A—CDE | A—CDE | A——D*E* | A—*C*DE | A—*C*DE |
| 22 .. | A—CDE | A—CDE | A——D*E* | ABCDE | ABCDE | A—CDE | A—*C*—*E* | A—CDE | ABCDE | — | A—*C*DE | A—*C*DE |
| 23 .. | A—CDE | A—*C*DE | A—*C*D*E* | A—*C*DE | A—CDE | A——— | A——D*E* | A—CDE | A—*C*DE | — | A—CDE | A—*C*DE |
| 24 .. | A—CDE | — | A——D*E* | A—CDE | A—CDE | — | A—*C*D*E* | A—CDE | A—*C*D*E* | — | A—CDE | A—*C*DE |
| 25 .. | A—CDE | — | A—*C*DE | ABCDE | A—CDE | A—*C*D*E* | A—*C*D*E* | AB*C*DE | A—CDE | — | A—*C*DE | A—*C*DE |
| 26 .. | A—*C*DE | A—*C*D*E* | A—*C*DE | A—*C*DE | A—CDE | ABCDE | A—*C*DE | ABCDE | A—CDE | A—*C*DE | A—CDE | A—*C*D*E* |
| 27 .. | A—CDE | AB*C*DE | A—CDE | ABCDE | A—CDE | A———*E* | A——D— | ABCDE | ABCDE | A—*C*DE | A—*C*DE | A—*C*DE |
| 28 .. | A—CDE | ABCDE | A—*C*DE | A—CDE | ABCDE | A—*C*D— | A——D*E* | AB*C*DE | A—CDE | A——D— | A—CDE | A—*C*D*E* |
| 29 .. | A—CDE | A—CDE | A—CDE | A—CDE | AB*C*DE | A——D*E* | ABCDE | ABCDE | A—CDE | — | A—*C*DE | A—*C*DE |
| 30 .. | A—CDE | | A—*C*DE | ABCDE | ABCDE | A——DE | A——D— | ABCDE | A—CDE | A——D*E* | A—CDE | A—CDE |
| 31 .. | ABCDE | | A—CDE | | ABCDE | | ABCDE | ABCDE | | A—*C*D*E* | | — |

*Note.*—When a letter is in italics it means that on that day observations were not complete.

SOLAR Observations—Abstract.

| — | 1908. January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 29 | 27 | 31 | 30 | 31 | 28 | 28 | 29 | 29 | 26 | 27 | 29 | 344 |
| B | 8 | 5 | 1 | 16 | 14 | 7 | 4 | 11 | 8 | 3 | 10 | 9 | 96 |
| C | 28 | 27 | 29 | 30 | 31 | 22 | 14 | 25 | 27 | 21 | 27 | 29 | 310 |
| D | 29 | 27 | 31 | 30 | 31 | 25 | 27 | 28 | 29 | 25 | 27 | 29 | 338 |
| E | 29 | 27 | 31 | 30 | 31 | 25 | 26 | 29 | 28 | 25 | 27 | 29 | 337 |

6. **Photographs of the sun** with the Dallmeyer photoheliograph were taken on 338 days, as against 339 in 1907. The worst month for this work was October, when six days were missed. Twelve solar negatives for 1908, 3 for 1907 and 30 for 1906 were sent to Greenwich to fill in the gaps in the Greenwich and Dehra Dun series of daily photographs. Double exposures are now taken twice a month for determining the error of orientation of the solar photographs. Formerly this error was determined by actual measurements made on the ground glass and these determinations were probably equally accurate, but there are certain advantages in the permanent record. The chief drawback is that the want of rigidity in the mounting of the instrument renders it somewhat difficult to obtain the two exposures without shaking the telescope.

Tests of the object glass of the photoheliograph show that it is not altogether suitably corrected, and during part of the year a new object glass, which was got for the spectrograph, was used. It is proposed to apply for a new instrument of more modern design.

A number of large-scale photographs of individual spots have been taken both with the 20-foot lens and the 40-foot lens. Some of these show great detail in the spot structure.

7. **Observations of sunspots.**—The sun is examined for spots and faculae every morning when the weather permits. The sun's image is projected on an 8-inch disc and the positions of spots and faculae are marked on it. In previous years and up to April 30 of the year under report this disc was blank except for the north-south and east-west lines, but the discs in use since that date have lines of solar latitude and longitude printed on them. The discs are printed by the cyanotype process from negatives made from the large drawings prepared by Father R. de Beaurepaire. These were drawn for differences of half a degree in the latitude of the sun's centre and consequently the positions of spots can be obtained by inspection with considerable accuracy.

8. **Sunspot spectra.**—(*a*) *Visual.*—This work is done in accordance with the suggestions issued by the Committee of the International Union for Solar Research. It includes the comparison of the spot spectrum with Hale's provisional photographic map for the region 5210Å to F and the detailed study of the following lines :—5383·58, 5397·34, 5404·36, 5405·99, 5424·29, 5429·91, 5445·26, 5447·13, 4924·1, 5234·79, 5316·79 and 5535·06.

(*b*) *Photographic.*—Good photographs of spot spectra have been obtained during the year in the regions C to D and G to K with spectrograph No. II. Spectrograph No. I has also been employed, chiefly in the region about D and from F to G.

9. **General spectroscopic work.**—Spectrograph No. II has been employed by the Assistant Director on the following lines of investigation :—

(1) Determinations of the rotation velocities of the higher gases of the chromosphere.

(2) Determinations of the rotation velocities of the quiet prominences at a considerable height above the sun's limb.

(3) Determinations of relative shifts of certain lines in spot and in limb spectra; the lines chosen being those subject to large pressure shifts.

(4) Determination of the amount and probable cause of the general shift towards the red of the lines at the sun's limb discovered by Halm.

(5) Discussion of the differences in the relative intensities of the lines in the spectra of the sun's limb and centre; and the relation of limb to spot spectra.

A large number of good plates have been obtained during the year and a considerable proportion of these have been measured and discussed. The relative pressure in the region of absorption in spots and in the photosphere has been determined and in the limb spectra certain iron lines most affected by pressure are found to be systematically displaced about 0·005 Å towards the violet compared with the same lines at the sun's centre. The general shift of all the lines at the limb towards the red is clearly brought out by the measures but the precise amount of this shift is not yet determined.

10. **Prominences.**—Prominences were recorded visually on 310 days against 305 in 1907. On 48 days the combined visual and photographic record was imperfect owing to unfavourable weather conditions. The record of the prominences is made round the disc on which spots and faculæ have been projected and with the new discs, referred to above, the apparent latitudes of prominences are easily read off directly. The visual record is compared with the photographs taken with the spectroheliograph and all prominences shown in the photograph but not in the drawing are added in blue pencil. Where there is much difference between the photograph and the drawing the differences are noted. In the case of eruptive or metallic prominences the spectra are examined, the most conspicuous bright lines are recorded, and all large displacements of the C line are also noted and their amounts estimated.

11. **Spectroheliograms.**—The spectroheliograph was in use throughout the year and photographs of the disc in $K_2$ light were obtained on 337 days.

A new camera slit, made in the observatory workshop, was fitted in March and this has considerably improved the general quality of the photographs. On 42 days the results were not altogether satisfactory owing to unfavourable weather. Disc photographs have also been obtained with the camera slit set on the shading of the K line ($K_1$).

Prominence photographs in $K_2$ light were obtained on 300 days; very satisfactory results being obtained whenever the weather was favourable. The minutest details of structure in the prominences are clearly recorded, the photographs surpassing in this respect any drawings that can be made from eye observations. Several notable eruptive prominences have been photographed and their rapid changes of form recorded.

Measures are made of the position angles and heights of the prominences on the best limb photograph of each day and an enlarged positive of the best disc photograph is made on bromide paper. All such positives obtained during a month are correctly oriented and pasted on a large card-sheet this being found most convenient for a general study of the markings.

Prominence spectroheliograms for 55 days were received from the Solar Observatory, South Kensington, and flocculi plates for 328 days were sent in exchange.

12. **Solar radiation.**—Observations with an Ångström Pyrheliometer were begun in February 1908 and are made on all days that are suitable. These will usually be numerous during the first four months of the year but rare in the other months.

A new scheme has been devised for determining the amount and period of variations in the solar radiation which will be independent of all other methods at present in use, and free from many of the uncertainties attending them.

Owing to the accuracy with which the relative densities of photographic images may be determined with a suitable photometer, variations (if any) of the solar radiation not less than 1 per cent. ought to be determinable from photometric comparisons of images of the full moon and of certain selected stars known to be approximately constant in their light.

With this end in view apparatus has been prepared for obtaining out-of-focus images of bright stars on the same plate with similar images of the full moon. In order to reduce the moon's light to an amount comparable with that of a star and to employ the full aperture of the lens for both stars and moon, the latter is reflected at a known angle from a convex quartz plate. In this way the intensity can be reduced by any desired amount and the out-of-focus image formed from the integrated light of the whole disc of the moon becomes a circular disc of uniform density similar in all respects to that produced by the stars The relative densities can then be easily measured. The moon and stars are photographed at altitudes not less than 60° and, for each plate, at as nearly as possible the same altitudes.

The only sources of uncertainty to which this method seems subject are want of uniformity in the transparency of the sky near the zenith and possible small variations in the magnitudes of the stars chosen for comparison.

A series of photographs taken during each lunation before and after full moon during good atmospheric conditions should eliminate the former uncertainty, whilst errors arising from the latter could be neutralised by taking a sufficient number of comparison stars

A considerable amount of experimental work has already been done and it is hoped that a systematic series of comparisons will shortly be commenced.

*Summary of Results.*

13. **Sunspots.**—The following table shows the monthly number of new groups observed, the mean daily number of spots visible, and the distribution between the northern and southern hemispheres:—

| | January | February | March | April | May. | June | July | August | September | October | November | December | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups .. .. | 24 | 17 | 16 | 35 | 26 | 19 | 23 | 26 | 21 | 15 | 19 | 21 | 262 |
| Daily number .. | 3·5 | 3·4 | 2·7 | 5·3 | 4·4 | 3·8 | 3·5 | 5·0 | 5·0 | 2·9 | 3·6 | 3·7 | 3·9 |
| North . .. .. | 11 | 6 | 4 | 9 | 9 | 11 | 8 | 12 | 11 | 8 | 9 | 12 | 110 |
| South . .. .. | 13 | 11 | 12 | 26 | 17 | 8 | 15 | 14 | 10 | 7 | 10 | 9 | 152 |

During the whole of 1906 northern groups were far more abundant than southern ones and this state continued till March 1907. In April the southern groups preponderated and have continued to do so except in September and October 1907 and June, October, and December 1908. In April, groups were nearly three times as numerous in the south as in the north.

The mean latitude of the spots varied somewhat irregularly from month to month but the mean latitude for 1908 was less than for 1907. The change was from 10°·9 in the northern hemisphere and 12°·4 in the southern in 1907, to 9°·9 in the northern and 10°·7 in the southern in 1908. This change is normal for this epoch in the spot cycle.

There was a considerable fall in spot activity in the year under report, there having been only 262 new groups with a daily average of 3·9, against 301 and 4·6 in 1907. The maximum daily average in any one month was 5·3 in April, as against 7·1 in February 1907 and 7·2 in July 1906

On four days the sun's surface was quite free from spots at the time of observation. The lower spot activity is also indicated by the fact that there were fewer returns of old spots and only one returned for a second time; in the previous year there were many returns and one of them came round five times.

Some 60 large spots were seen during the year and the following notes refer to the most important of these:—

Nos. 1321, 1323, 1343, 1352 — These four groups seen in January and February behaved more or less alike. They came into view containing large spots which, however, tended to dwindle rapidly and disappear as they neared the west limb. The case of No. 1343 was somewhat striking. It came round the east limb as a regular

| | |
|---|---|
| | spot on January 29. On February 1 it was still a fairly large spot but with the umbra divided; on the 2nd the whole spot broke up into two nearly equal parts; the following spot, however, was reduced to a biggish dot on the 3rd and disappeared on the 5th. |
| Nos. 1361, 1469, 1483 | These three belonged to the class of spot groups developing rapidly as they approached the west limb. No. 1361 formed on February 26 as a train of dots within 4 days march of the west limb and developed very large spots within the next two days. It must, however, have filled up rapidly; for it did not return. The growth of No. 1483, which was first seen on August 13, was nearly as large and rapid. |
| Nos. 1378, 1379, 1388, 1406, 1407, 1408, 1409, 1433, 1434, 1437, 1438 | All these groups contained fairly large spots and were most of them active as indicated either by changes in form from day to day or by disturbances in the C and $D_3$ lines in their spectra. But the chief feature about them was that they were confined to one particular region of the surface with mean heliographic longitude about 170.° The first three were visible at one time, in the early part of April, the second four in May, and the third four in June. The spot activity in those months was not great outside that region. Two other fairly large groups, Nos. 1452 and 1453, were seen about the end of June, and they too were very near this region. |
| Nos. 1477, 1478, 1479, 1489, 1496, 1498, 1503 | These were found in another active part of the sun's surface. The region lying between latitudes + 15° and — 20° and longitudes 30° and 34° was on the visible hemisphere in the early part of August and contained the first four large and active groups. C, $D_1$, $D_2$ and $D_3$ were bright over the umbrae of 1478, on the 3rd and 5th. When this region came round the east limb again, about the end of the month, it still contained 6 groups, 3 of which, Nos. 1496, 1498, and 1503 were large; C was strongly reversed on one of the spots in 1496 on the 30th. But the region of greatest activity appeared to have drifted in a north-westerly direction, for its limits now were latitudes + 20° and — 15° and longitudes 45° and 355°. |
| No. 1545 | This formed on the visible disc near the east limb on November 7 as a few dots, but developed a large spot by the morning of the 8th. It rapidly developed further till it became a train of large spots. Reversals and displacements of C and the darkening of $D_3$ were frequently seen in this group. |
| No. 1571 | was first seen as a few dots on December 18 about 15° to the east of the central meridian. On the 19th it became a fairly large double spot group and did not change much after that date. |
| Nos. 1578, 1580 | These were large spots that came round the east limb about the end of December. No. 1580 was a return of 1561; C was reversed on its umbra on January 4, 1909. |

14. **Prominences.**—The year as a whole has been one of great activity. The mean profile area for the first six months reached 6·67 square minutes per diem, this being considerably in excess of any previous estimates. During the second half of the year the mean area fell to 3·93 square minutes per diem.

The general activity of the two hemispheres compared with the previous year is given in the following table :—

*Mean daily profile areas of Prominences.*

| | 1907. Square minutes. | 1908. Square minutes. |
|---|---|---|
| North .. .. | 1·92 | 2·41 |
| South .. .. | 2·27 | 2·98 |
| Total .. | 4·19 | 5·39 |

The unsymmetrical distribution of the prominences in the two hemispheres noticed in the last report has continued and the southern polar region has produced many large prominences, the activity of this region has however shown a marked decrease in the later months of the year.

Two zones of great activity are indicated in the northern hemisphere, in latitudes 10° to 15° and 30° to 35°, whilst south of the equator the greatest activity is in the zone 15° to 20°, with a secondary maximum between 45° and 55°.

Metallic prominences were far more numerous in the southern hemisphere than in the northern and they extended over a greater range of latitude in the south than in the north.

The mean and extreme latitudes observed are given in the following table :—

| — | Number observed. | Mean latitude. | Extreme latitudes. | |
|---|---|---|---|---|
| North .. .. .. | 23 | 14°·6 | 3° | 34° |
| South .. .. .. | 58 | 16°·8 | 2° | 50° |

There were in addition to the above three metallic prominences recorded in high latitudes ; one in the north in latitude + 69° and two in the south in latitudes − 58° and − 78°.

The prominence activity in each month may be estimated from the following table :—

| Month. | Prominences one minute or more in height. | Metallic prominences. |
|---|---|---|
| January .. .. .. .. .. | 71 | 21 |
| February .. .. .. .. .. | 53 | 8 |
| March . .. .. .. .. | 69 | 12 |
| April .. .. .. .. .. | 88 | 16 |
| May .. .. .. .. .. | 67 | 9 |
| June .. .. .. .. . | 33 | 3 |
| July .. .. .. .. .. | 27 | .. |
| August .. .. .. .. .. | 48 | 4 |
| September .. .. .. .. .. | 25 | .. |
| October .. .. .. .. .. | 42 | 2 |
| November .. .. .. .. .. | 52 | 6 |
| December .. .. .. .. .. | 39 | 3 |

The usual apparent deficiency of metallic and tall prominences during the monsoon months is evident, but November having been exceptionally fine, as noted previously, does not show this deficiency.

The following were the more noteworthy prominences of the year :—

*January.*—The highest prominence of the month, at latitude−48° west on the 12th, was a changing, irregular streak 150″ high at $9^h$ $16^m$ and 200″ at $9^h$ $48^m$. It occurred in an active region in which fairly large prominences were observed almost every day from the 11th to the 20th. An eruptive prominence at latitude−18° west on the 19th underwent rapid changes of form, but unlike most prominences of the kind persisted until the next day.

*February.*— One of the largest prominences ever observed was recorded on the 18th. Between $8^h$ and $9^h$ it was a more or less connected group occupying 30° of the east limb and 75″ high at the highest part. It was, however, changing both in form and height and was repeatedly photographed until sunset. The main feature indicated by the successive photographs was the vertical rise, with an accelerating speed, of the entire mass. The highest point recorded was 9 minutes from the limb, measured on the last photograph. It had disappeared by next morning.

Eruptive prominences reaching to considerable altitudes were also photographed on the 4th and 17th, both on the west limb and in latitude $-60^\circ$.

The spectrum of a prominence at the east limb on the 7th showed about 30 lines, belonging mainly to Na, Mg, Fe, Ti, and He. The list also contained certain "unknown" lines.

*March.*—There were two prominences $2\frac{1}{2}'$ high in this month; one on the equator on the 7th, and one near the south pole on the 14th.

*May.*—A persistent group of large prominences was visible alternately on the west and east limbs, which reached its maximum development on the 17th of this month. It first appeared on March 28, was conspicuous in April, and vanished early in June.

*July.*—A prominence observed at latitude $+10^\circ$ east on the 31st underwent many minor changes as shown by successive Ca photographs, but the main part which had the form of a well defined ring or horse-shoe persisted with little or no change in all the photographs of that day and could also be traced in a photograph taken on the previous day. This prominence was associated with spot No. 1478, first seen at the east limb on the 31st and which showed reversals of C, $D_1$, $D_2$ and $D_3$ on the umbra as it advanced westwards.

*August.*—The highest prominence of the month was photographed in Ca, on the 13th, at latitude $-28^\circ$ east. It was $210''$ high at $7^h\ 59^m$ but had totally disappeared by $8^h\ 23^m$. Close to it was a group of bright prominences showing displacement towards red of 2 Å in F and about 1Å in $D_3$. It was photographed eight times between $7^h\ 59^m$ and $10^h\ 43^m$ and underwent great changes during this period.

On August 11 at latitude $-16^\circ$ west F was displaced about 4 Å to red and 3 Å to violet at $9^h\ 9^m$ but there was then no prominence in that position. At $9^h\ 12^m$ the displacement had almost gone and a prominence had appeared $20''$ high. The height had increased to $70''$ by $9^h\ 14^m$ and to $90''$ by $9^h\ 18^m$ but the top was then very faint. There was no displacement whatever at $9^h\ 16^m$.

*September.*—On the 1st at $9^h$ F was displaced to violet at latitude $-9^\circ{\cdot}5$ east; at this position there was a small prominence which very rapidly increased in height from less than $10''$ at $9^h\ 2^m$ to $100''$ at $9^h\ 8^m$ and $120''$ at $9^h\ 10^m$. The amount of displacement and the area affected were changing rapidly. At $9^h\ 5^m$ it extended over a wide area and the maximum amount was 6 Å. It was only 3 Å and confined to one point at $9^h\ 13^m$ and it was still further reduced at $9^h\ 25^m$, but the direction was still towards violet. At $9^h\ 27^m$, however, F was displaced 1·5 Å to red from latitude $-10^\circ$ to $-14^\circ$. The amount was 6·4 Å to red in C at $9^h\ 30^m$. The form and height were changing in the meantime equally rapidly. The height had increased to $150''$ by $9^h\ 15^m$, but fell to $40''$ at $9^h\ 33^m$, $25''$ at $9^h\ 39^m$ and $15''$ at $9^h\ 49^m$. In the Ca photographs the eruption was not recorded, probably on account of the large displacement of the spectrum lines which would throw the Ca line K off the camera slit of spectroheliograph.

*October.*—A group of very tall and faint disconnected streaks extending over $35^\circ$ of the north-east limb was photographed at $8^h\ 17^m$ on the 12th. The tallest of them reached a height of $6\frac{1}{4}'$. Later photographs showed the group to be rapidly fading and there was nothing left by $10^h\ 11^m$.

Another eruptive prominence was seen on the same day near the south pole; it was $150''$ high at $8^h\ 17^m$ and attached to the limb at one point only; by $8^h\ 57^m$ it was completely detached, the base being $60''$ above the limb and the top $150''$. It continued rising till $11^h\ 30^m$ when only a small cloud remained $360''$ above the limb and this had vanished at $14^h\ 34^m$.

*November.*—The tallest prominence of the month was observed on the west limb on the 13th and was found to be rapidly changing. It was $270''$ high in Ca at $9^h\ 26^m$, but the height was only $70''$ at $9^h\ 54^m$ and there was nothing left by $10^h\ 22^m$.

*December.*—A group of prominences on the north-east limb on the 14th was $90''$ high at $8^h\ 58^m$ but rose to $180''$ in about three hours. The maximum height was $240''$ at $13^h\ 45^m$. More striking than the increase in height were the rapid changes in form the prominences were undergoing throughout the period of observation.

Another remarkable prominence was observed at the east limb on the 27th, apparently associated with the large spot No. 1578 then nearing the east limb. When first seen it was an ordinary, compact bank occupying about 16° of the limb and 50″ in height. At $9^h$ $22^m$ it had apparently burst asunder and at the northern extremity there appeared a floating cloud 140″ above the limb which in subsequent photographs was seen to grow larger, rise higher, and drift rapidly northwards. The maximum height measured was 5′ at $11^h$ $12^m$, when only a small bright cloudlet remained. At $9^h$ $47^m$ an enormous eruption burst out from a point 4° south of the original prominence and streamed northward arching over the remains of the earlier outburst. This also rose to a height of 5′ and then quickly dissolved away.

(*b*) Other Observations.

15. **Time.**—The error of the standard clock is usually determined by reference to the $16^h$ signal sent from the Madras Observatory. This is rendered possible by the courtesy of the Telegraph department which permits the Madras wire to be joined through to this observatory. The signal is received with accuracy on most days and all failures are at once reported to the officer in charge of the Madura division who takes much interest in the accuracy of the time service. Time determinations are made with the transit instrument at frequent intervals as a check.

The mean-time standard clock and two chronometers were cleaned during the year.

The usual time signal to the station was given, by means of a flag, throughout the year.

16. **Meteorology.**—Meteorological observations were carried on as in former years. Eye observations are made at $8^h$, $10^h$ and $16^h$ local mean time. Temperatures and pressure are recorded by a Richard thermograph (wet and dry bulb) and barograph, and the mean temperatures and pressure are obtained from the traces corrected by reference to the eye observations. The wind direction and velocity are got from a Beckley anemograph.

*Temperature.*—The mean temperature for the year was 56°·2 or 0°·1 below the average. In January the temperature was nearly a degree above the average; in March it was 1°·1 and in November 2°·3 below the average. The highest shade temperature was 75°·2 on April 25 and the lowest 38°·0 on December 10. The highest temperature in the sun was 141°·4 on April 12, and the lowest temperature on the grass was 19°·2 on January 23.

*Humidity.*—The mean relative humidity for the year was the same as the normal. The largest departures from normal were in February when it was 7 per cent. below and March when it was 7 per cent. above normal.

*Rain.*—The rainfall for the year as a whole was nearly normal but the distribution was peculiar. The fall was largely in excess in February and October and largely in defect in May, November, and December. Rain fell on only 4 days in November and on 3 days in December against a ten years' average of 17 and 13 days. The heaviest fall on one day was 2·38 inches on February 24.

*Wind.*—On the average for the year winds were slightly weaker and 1 point more northerly than usual. The strength was largely below normal in January, June, July, and September and largely above normal in November. The largest amount of wind on any one day was 776 miles on December 24, and the smallest amount was 92 miles on June 4.

*Transparency of the atmosphere.*—The transparency of the lower atmosphere as judged by the visibility of the Nilgiris—100 miles distant—was about normal.

*Cloud and sunshine.*—The year was on the whole less cloudy than usual and the amount of bright sunshine was 184 hours above the average. There was an excess of bright sunshine in all months except July and October The excess was large in April, November, and December.

17. **Seismology.**—The Milne horizontal pendulum worked well throughout the year and the results are given in appendix I. Earthquakes were very numerous and the number recorded here was 67 as against 24 in 1907. The original records of the earthquakes are retained at the Observatory, but copies of the more important shocks are sent to the British Association Committee, the Strassburg International Bureau, and to other workers on the subject who ask for them.

18. **Library.**—The library catalogue was completed and has been kept up to date. One hundred and sixty-four books were bound during the year.

19. **Publications.**—Bulletins Nos. XII. and XIII., which complete Volume I., were issued during the year and No. XIV. was in type at the close of the year. They all deal with prominence observations. Part I. of the Memoirs of the Observatory is nearly ready for the press. It is devoted to a full discussion of the photographs of sunspot spectra taken in 1907. In addition to these the following papers were published during the year:—

"Solar Prominences in 1907, observed at the Kodaikánal Observatory" by John Evershed. (M.N., R.A.S. Vol. LXVIII., No. 7.)

"A Large Prominence" by John Evershed. (A.P.J. Vol. XXVIII., No. 1.)

"Note on the Wave-length of H$\delta$ and H$\epsilon$ in the solar spectrum" by John Evershed. (A.P.J. Vol. XXVIII., No. 2.)

20. **General.**—The Director-General of Observatories visited the Kodaikánal and Madras Observatories in February. He was accompanied by Prof. and Mrs. Schuster.

The Director visited Madras in November and superintended the erection of the new dome for the 8-inch equatorial and re-erected the telescope. He also re-wired the transit instrument and the collimators and readjusted them.

The sanction of Government has been obtained for an electric installation for the Observatory and it is hoped that the work will begin at an early date.

The staff of the Observatory worked well throughout the year and so made it possible to keep abreast of the ever-growing work.

KODAIKÁNAL,
*3rd February* 1909.

C. MICHIE SMITH,
*Director, Kodaikánal and Madras Observatories.*

## II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1908.

1. **Staff.**—Mr. R. Littlehailes was in charge of the Observatory till the 7th of September, when I returned from furlough and relieved him.

Both the computer and the second assistant were on privilege leave during the year. Mr. M. G. Subrahmanyam, the first assistant, left the Observatory on the 8th February to take up his work at the Bombay Meteorological office, and Mr. A. A. Narayana Aiyar was appointed in his place.

2. **Time service.**—No change was made during the year in the programme of astronomical observations, nor in the system of time signals distributed from the Observatory. In the meridian observations, which formed practically the whole of the work, all the transits were recorded on the chronograph, and the determinations have on the whole been very satisfactory. The time-gun at the Fort was fired correctly at noon and 8 P.M. on 705 occasions out of 732, giving 96·3 as the percentage of successes against 97·1 last year. Bad tubes, defects in the apparatus and line, have been the causes of the failures. As we have no measuring instrument here to test the current in the line and its insulation, it is not possible to differentiate quickly and with certainty between the two latter sources of trouble. Proposals relating to this matter will form the subject of a separate communication. The time ball at the Port office was dropped at 1 P.M. correctly on all occasions except 13. On eight of these it was dropped correctly at 2 P.M. None of these failures were due to faults at the Observatory.

Since the 11th April records of the 8 and 16-hour roll of signals have been taken by the chronograph, the tape receiving at the same time seconds from the Riefler clock. These show that the hand-sent signals are extremely good and that any improvement in the sending effected by substituting an automatic arrangement would not be appreciated unless the methods of receiving the signals are very materially improved.

3. **Meteorological observations.**—Meteorological observations were made at the usual hours 8, 10, 16, and 20 local mean time. The 10-hour and 16-hour observations were reduced and sent to the India Meteorological office on Form F. Observations on cloud movement were continued. Besides the ordinary weather messages, special storm observations were sent on one occasion to Simla and on 133 occasions to Calcutta. The tabulations of the traces of the autographic meteorological instruments at Madras and of the Anemograph at Dodabetta are brought up to date.

4. **Buildings.**—Certain repairs to the buildings were effected during the year. In September the materials for the construction of a new dome over the 8-inch equatoreal were received from England. The clock, the telescope and its mountings were safely taken down early in October, and the work of removing the old dome and preparations for erecting the new one taken in hand at once. All work was however stopped by the heavy rain at the end of October. In November the Director visited the Observatory and during the fine weather that set in after the first week, the work on the new dome was resumed under his superintendence, and I was relieved of responsibility in a matter in which I had no previous experience to guide me, and no time to acquire any by a tedious process of trial and error. The erection of the dome was completed and the telescope remounted early in December and nearly all work on the structure was finished before the end of the year.

5. **Instruments.**—The following is the list of instruments at the Madras Observatory on the 31st December 1908 :—

(*a*) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton & Simms.
Sidereal Clock—Haswall.
" Dent, No. 1408.
" S. Riefler, No. 61.
Mean Time Clock with galvanometer—Shepherd & Sons.
Meridian Circle—Troughton & Simms.

Mean Time Clock—J. Monk.
Mean Time Chronometer—V. Kullberg, 5394.
,, ,, 6544.
,, Parkinson & Frodsham, 2352.
Portable Transit Instrument—Dolland.
Portable Telescope with stand.
Tape Chronograph—R. Fuess.
Relay for use with the Chronograph—Siemens.

(*b*) *Meteorological.*

Richard's Barograph—No. 10, L. Casella.
Richard's Thermograph—No. 3618, L. Casella.
Beckley's Anemograph—Adie.
Sunshine Recorder—No. 149, L. Casella.
Anemoscope—P. Orr & Sons.
Nephoscope—Mons. Jules Daboscq & Ph. Pellin.
Barometer, Fortin's—1771, L. Casella.
,, 725, L. Casella (spare).
,, 1420, L. Casella (spare).
Dry Bulb Thermometer—No. 94221, L. Cassella.
,, No. 38037, Negretti & Zambra (spare).
Wet Bulb Thermometer—No. 94219, L. Casella.
,, No. 38037, Negretti & Zambra (spare).
Dry Maximum Thermometer—No. 8581, Negretti & Zambra.
Dry Minimum Thermometer—No. 69047, L. Casella.
Wet Minimum Thermometer—No. 91753, Negretti & Zambra.
Sun Maximum Thermometer—No. 10479, Negretti & Zambra.
Grass Minimum Thermometer—No. 3377, Negretti & Zambra.
Rain-gauge (8" diameter)—No. 1042, Negretti & Zambra.
Measure glass for above.
Rain-gauge (5" diameter).
Measure glass for above.

The micrometer frame of the transit was rewired by the Director in November, and a new system of wires was put in the south collimator; the north collimator was also rewired. The instrument has been steady throughout the year. The Riefler keeps a steady rate for long periods. On September 11–12, however, it was subjected to some unknown disturbance and gained as much as 12 seconds in 18 hours. Its daily rate had been 0·15 second, gaining, previous to this and was very unsteady for some weeks after this. During the last two months of the year the rate has been remarkably steady.

The Haswall clock which was taken down with the telescope had not been put up again at the end of the year.

6. **Weather summary.**—The following is a summary of the meteorological conditions at Madras during the year 1908 :—

*Pressure.*—Pressure was above normal in January, March, July, and December, below normal during the other months; in May it was normal. The greatest excess was 0·020 inch in January and the greatest defect was 0·041 inch in April. The highest pressure was 30·176 inches on January 8 and the lowest 29·569 on June 29.

*Temperature.*—The mean temperature was above the average in all months except September, November, and December. The maximum shade temperature was also above normal in all months except January, February, September, November, and December, the greatest excess being 3·9 in June and the defect being 2·4 in September. The minimum in the shade was above normal in January, February, April, May, June, and July and below normal in the remaining months; the minimum on grass was below normal in March, October, November, and December and above normal during the other months. The maximum in the sun was below the average in all the months of the year. The highest shade temperature recorded was 109°·6 on April 26 and May 30, and the lowest 60°·8 on January 20; the highest reading of the black bulb thermometer in vacuo was 154°·0 on May 11.

*Humidity.*—The percentage of humidity was normal in June and November, in slight defect in March and December and above normal in all the other months. The driest day was March 8 with 13 per cent. of humidity.

*Wind.*—The wind direction was normal or nearly normal in all months except in October when it was 3 points more southerly. The amount of air movement was in defect throughout the year.

*Cloud.*—The percentage of cloud was in slight excess in February, March, and July and in defect in all the other months.

*Sunshine.*—The percentage of bright sunshine was below normal throughout the year, the greatest defect being 21·9 in February. There were 2,145·8 hours of bright sunshine during the year.

*Rainfall.*—The rainfall was above the average in February, August, September, and October and below during the remaining months of the year. The greatest excess was 13·78 inches in October and the defect was 3·00 inches in December. The rainfall for the whole year was 55·97 inches on 88 days, being 6·95 inches above the normal. The monsoon rainfall from October 15 to the close of the year was 39·07 inches against an average of 26·00 inches. The greatest fall on any day was 7·28 inches on October 23.

*Storms.*—(1) On the 25th September, a storm crossed the coast near Cocanada, and caused a strong indraught from the Arabian sea across the Peninsula, followed by exceptionally heavy rain in the Deccan during the period 26th to 28th.

(2) On the 29th December a storm of some severity was formed in the south-west of the Bay and moved in a westerly direction giving moderate to heavy rain at Madras and over the south of the Presidency.

Madras Observatory,
*3rd February* 1909.

R. Ll. Jones,
*Deputy Director.*

# Appendix I.

KODAIKÁNAL Observatory Seismological Records in 1908.

| No. | Date. | P.T. Commence G.M.T. | L.W. Commence G.M.T. | Maxima G.M.T. | End. | Max. Amp. | Duration. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | 1908. | H. M. | H. M. | H. M. | H. M. | MM. " | H. M. | |
| 2 | Jan. 11 .. | 3 43·8 | 4 00·8 | 4 05·3 | 5 04 | 6 0 = 2·6 | 1 20 | |
| 3 | 12 .. | .. | 10 32·1 | 10 34·1 | 10 42 | 0·2 = 0·1 | 0 10 | |
| 4 | 15 .. | 13 35·2 | 13 38·2 | 13 39·1 | 13 54 | 0·2 = 0·1 | 0 19 | |
| 5 | 25 .. | 20 22·3 | .. | .. | 20 28·5 | .. | 0 06 | Widening of line. |
| 6 | 27 .. | 16 06·2 | 16 13·5 | 16 15·5 | 16 27 | 0·6 = 0·3 | 0 21 | |
| 7 | 29 .. | 21 25·9 | .. | .. | 21 39 | .. | 0 13 | Widening of line. |
| 8 | Feb. 2 .. | 0 43·5 | 0 46·0 | 0 52·8 | 1 12 | 0·6 = 0·3 | 0 28 | |
| 9 | 6 .. | 1 35·2 | 1 40·1 | 1 44·3 | 2 12 | 0·4 = 0·2 | 0 37 | |
| 10 | 9 .. | 18 18·0 | 18 26·6 | 18 31·0 | 19 21 | 3·0 = 1·4 | 1 03 | |
| 11 | 11 .. | 14 33·1 | .. | .. | 14 40 | .. | 0 07 | Widening of line. |
| 12 | Mar. 4 .. | ? | 15 24·3 | 15 25·9 | 15 32 | 0·5 = 0·3 | ? | |
| 13 | 5 .. | 2 26·4 | 2 46·5 | 2 51·6 | 4 11 | 4·5 = 2·2 | 1 45 | |
| 14 | 13 .. | 6 27·9 | 6 34·3 | 6 36·4 | 6 54 | 0·4 = 0·2 | 0 26 | Felt at Mandalay. |
| 15 | 15 .. | 10 06·1 | 10 13·3 | 10 18·4 | 10 40 | 1·4 = 0·7 | 0 34 | |
| 16 | 23 .. | 12 32·3 | 12 57·7 | 12 58·8 | 13 16 | 1·5 = 0·7 | 0 44 | |
| 17 | 26–27 .. | 23 23·8 | 23 46·6 | 23 48·6 | .. | 1·6 = 0·8 | .. | |
| | | .. | .. | 0 43·3 | .. | 2·9 = 1·5 | .. | |
| | | | .. | 0 53·1 | 2 15 | 2·5 = 1·3 | 2 51 | Chilapa. |
| 18 | 27 .. | 4 15·0 | ? | ? | 6 03 | 0·5 = 0·3 | 1 48 | Sheet marked at $4^h 52^m$. |
| 19 | Apr. 2 .. | 6 15·1 | 6 24·4 | 6 27·4 | 6 51 | 0·6 = 0·3 | 0 36 | |
| 20 | 4 .. | 6 24·6 | 6 31·0 | 6 38·2 | 6 55 | 0·6 = 0·3 | 0 30 | Assam ? |
| 21 | 10 .. | 0 06·1 | 0 21·5 | 0 28·7 | 0 51 | 0·6 = 0·3 | 0 45 | |
| 22 | 16 .. | No P. Ts. | 17 52·2 | 17 53·7 | 18 01 | 0·5 = 0·2 | 0 09 | |
| 23 | 19 .. | 8 15·5 | .. | .. | 8 49 | .. | 0 33 | Widening of line. |
| 24 | 23 .. | 0 02·6 | 0 13·1 | 0 15·2 | 1 40 | 4·2 = 2·0 | 1 37 | |
| 25 | May 5 .. | 6 33·0 | 6 51·7 | 6 52·7 | 8 04 | 3·6 = 1·8 | 1 31 | |
| 26 | 5 .. | No P. Ts. | 11 22·3 | 11 23·3 | 12 03 | 3·0 = 1·5 | 0 41 | |
| 27 | 6 .. | 11 44·8 | .. | .. | 12 09 | .. | 0 24 | Widening of line. |
| 28 | 11 .. | 13 07·8 | 13 10·3 | 13 11·9 | 13 27 | 0·4 = 0·2 | 0 19 | |
| 29 | 15 .. | 8 56·7 | 9 27·4 | 9 32·5 | 10 56 | 1·1 = 0·5 | 1 59 | |
| 30 | 20 .. | 7 51·4 | 7 58·5 | 8 00·5 | .. | 0·8 = 0·4 | .. | |
| | | .. | .. | 08·6 | 8 52 | 1·0 = 0·5 | 1 01 | |
| 31 | June 3 .. | 15 59·7 | 16 07·8 | 16 08·5 | 16 46 | 2·4 = 1·2 | 0 46 | |
| 32 | 30 .. | 2 27·4 | 2 31·0 | 2 32·2 | 2 51 | 0·5 = 0·2 | 0 24 | |
| 33 | July 13 .. | 21 46·6 | 21 48·6 | 21 50·1 | 22 18 | 0·6 = 0·3 | 0 31 | |
| 34 | 20 .. | 12 38·2 | .. | .. | 12 48 | .. | 0 10 | Widening of line. |
| 35 | 26 .. | 16 12·0 | 16 20·8 | 16 22·3 | 16 52 | 2·0 = 1·0 | 0 40 | |
| 36 | 26 .. | 17 27·4 | 17 34·2 | 17 36·1 | 18 03 | 1·6 = 0·8 | 0 36 | |
| 37 | Aug. 4 .. | 14 29·7 | .. | .. | 15 47 | .. | 1 17 | Widening of line. |
| 38 | 12 .. | 16 01·7 | .. | .. | 17 18 | .. | 1 16 | Widening of line. |
| 39 | 12 .. | 18 56·0 | 19 16·0 | 19 51·0 | 19 55 | 1·0 = 0·5 | 0 59 | |
| 40 | 17 .. | 11 02·8 | 11 35·1 | 11 38·2 | 13 17 | 2·5 = 1·1 | 2 14 | |
| 41 | 20 .. | 9 53·7 | 10 06·6 | 10 09·1 | 11 28 | 2·6 = 1·1 | 1 34 | |
| 42 | 22 .. | 12 12·5 | .. | 12 17·2 | 12 29 | .. | 0 17 | Widening of line. |
| 43 | 22 .. | 19 33·6 | .. | .. | 19 51 | .. | 0 17 | Widening of line. |
| 44 | Sept. 9 .. | 6 54·6 | .. | .. | 7 16 | .. | 0 21 | Widening of line. |
| 45 | 9 .. | 20 42·3 | .. | .. | 20 51 | .. | 0 09 | Widening of line. |
| 45A | 21 .. | 6 01·0 | .. | .. | 7 58 | .. | 1 57 | Widening of line. |
| 46 | 23 .. | 7 09·0 | 7 13·1 | 7 15·1 | 8 10 | 4·1 = 1·8 | 1 01 | |
| 47 | 26 .. | 5 46·3 | 6 08·4 | 6 09·5 | 6 37 | 0·4 = 0·2 | 0 51 | |
| 48 | 28 .. | 6 41·6 | 6 53·0 | 6 55·5 | 7 10 | 0·6 = 0·3 | 0 28 | |
| 49 | Oct. 13 .. | 5 44·2 | 6 38·6 | 6 42·2 | 7 18 | 0·3 = 0·1 | 1 34 | |
| 50 | 14 .. | 15 37·7 | 15 41·8 | 15 44·9 | 15 49 | 1·0 = 0·5 | 0 11 | |
| 51 | 20 .. | 2 49·5 | 3 08·0 | 3 10·9 | 3 47 | 0·6 = 0·3 | 0 57 | |
| 52 | 24 .. | 21 26·4 | 21 27·4 | 22 01·6 | 22 16 | 0·7 = 0·3 | 0 50 | Punjab, Simla. |
| 52A | Nov. 2 .. | 5 18·2 | ? | 5 27·1 | 7 10 | 4 0 = 1·7 | 1 52 | Sheet cut $5^h 20^m$. |
| 52B | 2 .. | 7 28·0 | 7 30·5 | 7 32·0 | 7 57 | 1·1 = 0·5 | 0 29 | |
| 53 | 6 .. | 7 23·4 | 7 54·6 | 7 59·7 | 8 56 | 0·6 = 0·2 | 1 33 | |
| 54 | 6 .. | 14 15·1? | 14 38·2 | 14 39·2 | 15 07 | 0·7 = 0·3 | 0 52 | |
| 55 | 9 .. | 16 26·4 | .. | 16 36·1 | 16 53 | .. | 0 27 | Widening of line. |
| 56 | 11 .. | 13 26·2 | 13 45·8 | 13 47·4 | 14 51 | 4·0 = 1·7 | 1 25 | |
| 57 | 12 .. | 16 44·4 | 16 48·5 | 16 50·5 | 16 59 | 0·7 = 0·3 | 0 15 | |
| 58 | 12 .. | 22 00·8 | 22 06·4 | 22 09·0 | 22 21 | 0·9 = 0·4 | 0 20 | |
| 59 | 15 .. | 1 47·4 | 1 56·6 | 1 58·1 | 2 14 | 0·6 = 0·3 | 0 27 | |
| 60 | 23 .. | 12 58·7 | 13 20·3 | 13 22·3 | 13 35 | 0·6 = 0·3 | 0 36 | |
| 61 | 25 .. | 3 08·6 | .. | .. | 3 19 | .. | 0 10 | Widening of line. |
| 62 | Dec. 1 .. | 3 08·8 | 3 11·9 | 3 14·4 | 3 27 | 0·6 = 0·3 | 0 18 | |
| 63 | 12 .. | 12 59·9 | 13 04·5 | 13 10·6 | 14 25 | 5·0 = 2·3 | 1 25 | |
| 64 | 12 .. | 19 07·4 | 19 25·4 | 19 25·8 | 19 59 | 0·5 = 0·2 | 0 52 | |
| 65 | 18 .. | 15 42·6 | 15 49·6 | 15 52·7 | 17 07 | 3·6 = 1·7 | 1 24 | |
| 66 | 22 .. | 3 04·7 | .. | .. | 3 23 | .. | 0 18 | Widening of line. |
| 67 | 28 .. | 4 29·4 | 4 58 6 | 5 00·4 | 7 23 | 3·0 = 1·4 | 2 54 | Messina ; sheet cut $5^h 44^m$. |

# Appendix II.

Latitude—10° 13′ 50″ N.
Longitude—5h 09m 52s E.

Height of barometer cistern above mean sea level 7,688 feet.

MEAN monthly and annual Meteorological Results at the Kodaikánal Observatory in 1908.

| Month. | Barometer. | | Dry bulb thermometer. | | | | Wet bulb. | | Tension of vapour. | Relative humidity. | Sun Max. *in vac.* | Min. on grass. | Wind. | | | Rain. | | Clear sky. | Bright sun-shine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reduced to 32°. | Daily range. | Mean. | Max. | Min. | Range. | Mean. | Min. | By Blanford's tables. | | | | Daily velocity. | Mean direction. | | Amount. | Days. | | |
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | POINTS. | POINTS. | INCHES. | NO. | CENTS. | HOURS. |
| January .. | 22·862 | 0·074 | 54·0 | 63·9 | 47·8 | 16·1 | 48·0 | 42·1 | 0·280 | 67 | 114·5 | 36·9 | 287 | 10 | E. S. E. | 1·12 | 6 | 59 | 234·8 |
| February .. | ·822 | ·075 | 55·0 | 65·2 | 48·3 | 16·9 | 46·7 | 40·0 | ·240 | 55 | 120·0 | 38·2 | 329 | 2 | N. N. E. | 4·99 | 3 | 63 | 225·4 |
| March .. | ·857 | ·072 | 56·8 | 67·5 | 50·0 | 17·5 | 49·3 | 41·7 | ·280 | 61 | 128·7 | 38·7 | 299 | 8 | E. | 3·44 | 5 | 64 | 238·4 |
| April .. | ·822 | ·071 | 61·0 | 70·5 | 54·8 | 15·7 | 53·8 | 47·8 | ·346 | 65 | 130·3 | 46·0 | 297 | 8 | E. | 3·41 | 6 | 67 | 253·8 |
| May .. | ·818 | ·073 | 60·3 | 68·7 | 55·0 | 13·7 | 54·8 | 50·0 | 375 | 72 | 128·5 | 47·5 | 256 | 4 | N. E. | 5·06 | 10 | 50 | 222·2 |
| June .. | ·772 | ·060 | 58·0 | 65·0 | 53·7 | 11·3 | 53·6 | 49·5 | ·369 | 76 | 121·7 | 47·2 | 356 | 25 | W. by N. | 2·35 | 12 | 31 | 130·4 |
| July .. | ·771 | ·058 | 55·6 | 61·8 | 52·2 | 9·6 | 52·9 | 49·2 | ·376 | 85 | 111·7 | 48·5 | 407 | 27 | N.W.by W. | 4·89 | 13 | 17 | 75·0 |
| August .. | ·760 | ·061 | 56·5 | 63·3 | 52·4 | 10·9 | 53·4 | 49·2 | ·379 | 83 | 119·7 | 47·4 | 321 | 29 | N.W.by N. | 5·08 | 10 | 35 | 153·4 |
| September .. | ·762 | ·074 | 56·8 | 63·2 | 52·9 | 10·3 | 54·0 | 49·5 | ·392 | 85 | 120·1 | 48·7 | 254 | 28 | N. W. | 8·91 | 16 | 28 | 113·8 |
| October .. | ·787 | ·080 | 55·1 | 60·8 | 51·6 | 9·2 | 53·2 | 50·1 | ·388 | 89 | 112·2 | 46·2 | 263 | 2 | N. N. E. | 16·42 | 20 | 24 | 100·4 |
| November .. | ·796 | ·070 | 51·6 | 59·3 | 46·6 | 12·7 | 48·7 | 44·3 | ·317 | 82 | 111·3 | 41·6 | 323 | 25 | W. by N. | 1·73 | 4 | 52 | 194·5 |
| December .. | ·808 | ·066 | 53·3 | 63·3 | 46·5 | 16·8 | 47·1 | 40·9 | ·267 | 66 | 112·0 | 37·1 | 298 | 6 | E.N.E. | 1·77 | 3 | 51 | 235·4 |
| Annual .. | 22·803 | 0·070 | 56·2 | 64·4 | 51·0 | 13·4 | 51·3 | 46·2 | 0·334 | 74 | 119·2 | 43·7 | 308 | 1 | N. by E. | 59·17 | 108 | 45 | 2,177·5 |

EXTREME monthly Meteorological Records at the Kodaikánal Observatory in 1908.

| Month. | Barometer. | | | | | Dry bulb thermometer. | | | | Wet bulb. | | Humidity. | | Sun Th. *in vacuo.* | | Grass therm. | | Wind. | | | | Rain. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | | Lowest. | | Range. | Highest. | | Lowest. | | Lowest. | | Lowest. | | Highest. | | Lowest. | | Highest. | | Lowest. | | Greatest Fall. | |
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY. |
| January .. | **22·956** | 7 | 22·731 | 31 | 0·225 | 73·2 | 25 | 42·4 | 21 | 32·4 | 21 | 9 | 21, 25 | 124·0 | 13 | **19·2** | 23 | 595 | 6 | 136 | 15 | 0·23 | 7 |
| February .. | ·944 | 9 | ·731 | 23 | ·213 | 72·6 | 4 | 42·8 | 9 | 34·0 | 10 | 10 | 11 | 133·8 | 6 | 20·7 | 1 | 550 | 24 | 141 | 3 | **2·38** | 24 |
| March .. | 947 | 21 | ·766 | 1 | ·181 | 72·6 | 16 | 45·6 | 4 | 33·7 | 5 | 7 | 5 | 139·4 | 2 | 30·2 | 15 | 465 | 4 | 133 | 1 | 2·27 | 25 |
| April .. | ·907 | 21 | ·742 | 7 | ·165 | **75·2** | 25 | 51·8 | 13 | 41·2 | 13 | 25 | 22 | **141·4** | 12 | 36·6 | 3 | 480 | 13 | 224 | 17 | 0·76 | 17 |
| May .. | ·891 | 2 | ·734 | 6 | ·157 | 73·4 | 27 | 51·1 | 17 | 44·9 | 14 | 39 | 9 | 135·9 | 5 | 38·2 | 16 | 387 | 7 | 126 | 29, 30 | 1·32 | 7 |
| June .. | ·869 | 3 | ·691 | 24 | ·178 | 70·0 | 5, 7 | 50·7 | 16 | 43·8 | 21 | 39 | 21 | 136·6 | 2 | 36·4 | 2 | 688 | 30 | **92** | 4 | 0·32 | 11 |
| July .. | ·874 | 8, 9 | ·686 | 27 | ·188 | 65·7 | 2 | 49·9 | 30 | 44·5 | 1 | 49 | 1 | 132·1 | 3 | 40·9 | 8 | 716 | 1 | 151 | 7 | 1·10 | 7 |
| August .. | ·832 | 13, 25 | ·680 | 2 | ·152 | 66·6 | 23, 27 | 50·8 | 3 | 42·9 | 28 | 43 | 28 | 137·6 | 18 | 42·8 | 22 | 570 | 8 | 118 | 25 | 1·70 | 11 |
| September .. | ·847 | 19 | ·689 | 28 | ·158 | 67·5 | 30 | 50·4 | 19 | 41·1 | 24 | 35 | 24 | 139·2 | 22 | 43·4 | 25 | 407 | 27 | 114 | 18 | 1·30 | 8 |
| October .. | ·891 | 11 | **·642** | 24 | ·249 | 64·6 | 2 | 50·0 | 21 | 46·4 | 2 | 42 | 12 | 130·6 | 19 | 37·2 | 14 | 531 | 22 | 127 | 6 | 2·12 | 5 |
| November .. | ·893 | 9 | ·658 | 3 | ·235 | 64·7 | 23 | 40·6 | 15 | 38·0 | 12 | 34 | 7 | 122·6 | 21 | 32·6 | 21 | 611 | 1 | 139 | 25 | 0·55 | 26 |
| December .. | ·888 | 10 | ·673 | 31 | ·215 | 70·5 | 20 | **38·0** | 10 | **31·6** | 9 | **6** | 4, 20 | 120·3 | 5 | 20·5 | 8 | **776** | 31 | 160 | 5 | 0·90 | 24 |

# Appendix III.

Kodaikánal Mean Hourly Wind Velocity for the year 1908.

| Month. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hours. | | | | | | | | | | | | | | | | | | | | | | | |
| January .. .. .. | 11 | 11 | 10 | 12 | 12 | 12 | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 13 | 12 | 10 | 9 | 9 | 10 | 11 | 11 | 12 | 12 | 13 |
| February .. .. .. | 15 | 14 | 15 | 16 | 16 | 16 | 16 | 16 | 17 | 18 | 17 | 16 | 15 | 13 | 11 | 10 | 8 | 8 | 9 | 10 | 11 | 13 | 15 | 16 |
| March .. .. .. | 14 | 13 | 14 | 14 | 14 | 14 | 14 | 16 | 17 | 17 | 16 | 16 | 13 | 12 | 10 | 9 | 8 | 8 | 8 | 9 | 9 | 10 | 12 | 13 |
| April .. .. .. | 13 | 12 | 13 | 13 | 12 | 12 | 12 | 13 | 15 | 15 | 15 | 14 | 13 | 12 | 11 | 12 | 11 | 10 | 10 | 11 | 11 | 11 | 13 | 14 |
| May .. .. .. | 12 | 12 | 11 | 11 | 11 | 10 | 10 | 10 | 11 | 11 | 13 | 12 | 12 | 11 | 10 | 11 | 10 | 8 | 9 | 9 | 9 | 10 | 11 | 12 |
| June .. .. .. | 15 | 15 | 16 | 15 | 16 | 15 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 15 | 14 | 14 | 14 | 15 | 16 | 16 | 16 | 16 |
| July .. .. .. | 17 | 19 | 19 | 18 | 19 | 18 | 18 | 18 | 16 | 14 | 14 | 14 | 15 | 14 | 15 | 16 | 17 | 18 | 18 | 18 | 18 | 19 | 19 | 19 |
| August .. .. .. | 15 | 15 | 15 | 15 | 15 | 16 | 15 | 13 | 13 | 11 | 12 | 12 | 12 | 11 | 11 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 16 | 16 |
| September .. .. .. | 12 | 13 | 15 | 15 | 15 | 14 | 13 | 10 | 10 | 9 | 10 | 10 | 9 | 8 | 9 | 8 | 8 | 8 | 9 | 9 | 10 | 11 | 11 | 12 |
| October .. .. .. | 12 | 11 | 11 | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 12 | 12 | 12 | 11 | 12 | 11 | 10 | 11 | 10 | 10 | 11 | 11 | 12 | 12 |
| November .. .. .. | 15 | 15 | 16 | 16 | 17 | 16 | 15 | 15 | 14 | 14 | 15 | 14 | 14 | 12 | 11 | 11 | 9 | 11 | 11 | 12 | 12 | 13 | 14 | 13 |
| December .. .. .. | 13 | 13 | 13 | 13 | 13 | 13 | 14 | 13 | 13 | 15 | 15 | 14 | 14 | 13 | 12 | 10 | 9 | 8 | 11 | 12 | 11 | 12 | 13 | 13 |
| Annual .. | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 13 | 12 | 12 | 11 | 10 | 10 | 11 | 12 | 12 | 13 | 14 | 14 |

# Appendix IV.

Kodaikânal Mean Hourly Bright Sunshine for the year 1908.

| Month. | Hours. | | | | | | | | | | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6-7 | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 | |
| January .. .. | 0·15 | 0·73 | 0·79 | 0·86 | 0·83 | 0·87 | 0·83 | 0·73 | 0·61 | 0·56 | 0·53 | 0·07 | |
| February .. .. | ·09 | ·73 | ·89 | ·90 | ·85 | ·80 | ·79 | ·70 | ·72 | ·65 | ·52 | ·13 | |
| March .. .. | ·18 | ·85 | ·89 | ·92 | ·91 | ·83 | ·76 | ·65 | ·50 | ·48 | ·42 | ·31 | |
| April .. .. .. | ·21 | ·80 | ·93 | ·95 | ·97 | ·95 | ·87 | ·83 | 71 | ·55 | ·50 | ·20 | |
| May .. .. .. | ·19 | ·65 | ·90 | ·97 | ·93 | ·84 | ·74 | ·62 | ·49 | ·35 | ·35 | ·13 | |
| June .. .. .. | ·12 | ·38 | ·56 | ·59 | ·57 | ·49 | ·38 | ·33 | ·39 | ·22 | ·21 | ·10 | |
| July .. .. .. | ·05 | ·26 | ·41 | ·45 | ·39 | ·31 | ·20 | ·16 | ·09 | ·07 | ·02 | .. | |
| August .. .. | ·17 | ·59 | ·71 | ·70 | ·73 | ·70 | ·54 | ·32 | ·25 | ·15 | ·09 | .. | |
| September .. .. | ·01 | ·38 | ·63 | ·56 | ·59 | ·54 | ·39 | ·23 | ·13 | ·10 | ·17 | ·06 | |
| October .. .. | .. | ·32 | ·49 | ·49 | ·35 | ·42 | ·31 | ·21 | ·23 | ·21 | ·16 | ·04 | |
| November .. .. | ·08 | ·56 | ·83 | ·84 | ·82 | ·81 | ·67 | ·62 | ·57 | ·36 | ·27 | ·05 | |
| December .. .. | ·07 | ·51 | ·72 | ·85 | ·86 | ·86 | ·89 | ·85 | ·80 | ·70 | ·46 | ·04 | |
| Mean .. | 0·11 | 0·56 | 0·73 | 0·76 | 0·73 | 0·70 | 0·61 | 0·52 | 0·46 | 0·37 | 0·31 | 0·09 | |

# Appendix V.

Number of days in each month on which the Nilgiris were visible in 1908.

| Month. | Very clear. | Visible. | Just visible. | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January .. .. .. .. | 1 | 10 | 4 | 3 | 18 |
| February .. .. .. .. | .. | 8 | 1 | 3 | 12 |
| March .. .. .. .. | 5 | 4 | 6 | 1 | 16 |
| April .. .. .. .. | 3 | 1 | 3 | .. | 7 |
| May .. .. .. .. .. | 2 | 2 | 5 | .. | 9 |
| June .. .. .. .. .. | 9 | 7 | 2 | .. | 18 |
| July .. .. .. .. .. | 3 | 4 | 3 | .. | 10 |
| August .. .. .. .. | 3 | 8 | 5 | .. | 16 |
| September .. .. .. .. | 13 | 4 | 5 | 1 | 23 |
| October .. .. .. .. | 4 | 2 | 7 | .. | 13 |
| November .. .. .. .. | .. | 3 | 8 | 1 | 12 |
| December .. .. .. .. | 9 | 7 | 2 | 3 | 21 |
| Total .. | 52 | 60 | 51 | 12 | 175 |

Latitude—10° 9′ N.
Longitude—5h 10m 10s E.

# Appendix VI.

Height of barometer cistern above mean sea level 944 feet.

## Mean monthly and annual Meteorological Results at the Periyakulam Observatory in 1908.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer. Mean. | Dry bulb thermometer. Max. | Dry bulb thermometer. Min. | Dry bulb thermometer. Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. By Blanford's tables. | Relative humidity. By Blanford's tables. | Sun Max. *in vac.* | Min. on grass. | Wind. Daily velocity. | Wind. Mean direction. | Wind. Mean direction. | Rain. Amount. | Rain. Days. | Clear sky. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | POINTS. | POINTS. | INCHES. | NO. | CENTS. | |
| January .. | 28·888 | 0·123 | 75·7 | 86·8 | 66·3 | 20·5 | 66·9 | 63·1 | 0·549 | 61 | 137·0 | 62·5 | 40·2 | 12 | S.E. | 5·72 | 5 | 44 | |
| February .. | ·960 | ·156 | 76·6 | 89·6 | 65·0 | 24·6 | 66·3 | 60·9 | ·511 | 56 | 142·0 | 56·9 | 47·1 | 8 | E. | 2·19 | 3 | 62 | |
| March .. | ·973 | ·157 | 80·3 | 92·9 | 68·8 | 24·1 | 69·0 | 64·4 | ·563 | 54 | 147·0 | 60·6 | 46·6 | 11 | S.E. by E. | 5·19 | 5 | 68 | |
| April .. | ·860 | ·144 | 83·8 | 96·6 | 73·9 | 22·7 | 73·4 | 69·5 | ·652 | 57 | 150·4 | 68·3 | 42·4 | 30 | N.N.W. | 3·65 | 3 | 73 | |
| May .. | ·866 | ·117 | 82·7 | 96·3 | 72·7 | 23·6 | 72·5 | 68·8 | ·664 | 60 | 153·1 | 69·0 | 59·1 | 22 | W.S.W. | 3·18 | 5 | 66 | |
| June .. | ·839 | ·110 | 81·6 | 93·8 | 72·2 | 21·6 | 70·8 | 67·2 | ·609 | 57 | 150·3 | 69·0 | 89·9 | 20 | S.W. | 0·45 | 2 | 53 | |
| July .. | ·864 | ·107 | 81·1 | 92·8 | 72·2 | 20·6 | 79·5 | 67·2 | ·568 | 54 | .. | 69·0 | 83·3 | 16 | S. | 0·47 | 1 | 36 | Sun maximum Thermometer was in use only on 11 days in July. |
| August .. | ·854 | ·112 | 82·1 | 95·2 | 71·4 | 23·8 | 70·1 | 66·4 | ·577 | 53 | 153·6 | 66·7 | 83·2 | 19 | S.W. by S. | 0·40 | 1 | 59 | |
| September .. | ·862 | ·128 | 81·0 | 92·8 | 71·6 | 21·2 | 70·6 | 67·6 | ·553 | 52 | 150·5 | 67·3 | 74·0 | 28 | N.W. | 3·01 | 5 | 55 | |
| October .. | ·914 | ·127 | 79·3 | 89·2 | 71·4 | 17·8 | 71·1 | 68·2 | ·653 | 66 | 141·7 | 68·4 | 47·1 | 16 | S. | 8·80 | 12 | 51 | |
| November . | ·966 | 136 | 77·3 | 87·6 | 67·8 | 19·8 | 67·8 | 64·2 | ·559 | 59 | 138·1 | 61·7 | 32·2 | 15 | S. by E. | 0·30 | 1 | 68 | |
| December .. | 29·002 | ·132 | 75·8 | 87·1 | 64·4 | 22·7 | 65·3 | 60·8 | ·489 | 55 | 134·5 | 58·1 | 47·7 | 13 | S.E. by S. | 0·12 | 0 | 76 | |
| Annual .. | 28·904 | 0·129 | 79·8 | 91·7 | 69·8 | 21·9 | 70·3 | 65·7 | 0·579 | 57 | * 145·3 | 64·8 | 57·7 | 18 | S.S.W. | 33·48 | 43 | 59 | * Mean of 11 months. |

## Extreme monthly Meteorological Records at the Periyakulam Observatory in 1908.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry bulb thermometer. Highest. | | Dry bulb thermometer. Lowest. | | Wet bulb. Lowest. | | Humidity. Lowest. | | Sun. Th. *in vacuo*. Highest. | | Grass therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY. |
| January .. .. | 28·972 | 31 | 28·794 | 16 | 0·178 | 90·4 | 14 | 58·4 | 22 | 56·0 | 22 | 27 | 30&31 | 149·0 | 16 | 52·9 | 21 | 90·1 | 8 | 22·7 | 27 | 2·50 | 16 |
| February .. .. | **29·169** | 9 | ·798 | 2 | ·371 | 93·5 | 14 | **57·1** | 12&13 | **53·2** | 12 | **13** | 16 | 151·0 | 7 | **45·8** | 12 | 85·2 | 10 | 21·3 | 3 | 1·04 | 24 |
| March .. .. | ·144 | 12 | ·819 | 1 | ·325 | 97·1 | 15 | 57·9 | 11 | 53·5 | 11 | 14 | 10 | 154·6 | 15 | 46·9 | 11 | 80·3 | 25 | 20·4 | 1 | 2·38 | 25 |
| April .. .. | ·012 | 13 | ·720 | 28 | ·292 | **102·0** | 29 | 70·7 | 23 | 62·5 | 14 | 25 | 3 | 161·9 | 29 | 62·9 | 1 | 117·0 | 27 | 19·5 | 16 | **2·61** | 17 |
| May .. .. | 28·991 | 2 | ·720 | 8 | ·271 | 101·3 | 25 | 69·2 | 16 | 65·5 | 14 | 33 | 24 | 162·5 | 13 | 64·0 | 16 | 114·3 | 29 | 24·6 | 5 | 1·02 | 21 |
| June .. .. | ·939 | 3 | **·716** | 12 | ·223 | 99·6 | 1 | 67·7 | 21 | 63·2 | 6 | 30 | 2 | 163·1 | 26 | 63·0 | 21 | **169·5** | 11 | 22·0 | 14 | 0·18 | 14 |
| July .. .. | ·980 | 8 | **·716** | 27 | ·264 | 97·7 | 1 | 69·5 | 2 | 64·7 | 30 | 19 | 1 | 160·6 | 1 | 65·4 | 30 | 145·6 | 28 | 19·9 | 24 | 0·31 | 25 |
| August .. .. | ·955 | 25 | ·717 | 9 | ·238 | 98·2 | 27 | 67·6 | 28 | 61·7 | 28 | 30 | 25 | **171·0** | 4 | 61·2 | 28 | 132·0 | 26 | 35·1 | 30 | 0·11 | 31 |
| September .. .. | ·992 | 19 | ·722 | 25 | ·270 | 97·9 | 30 | 66·0 | 25 | 62·5 | 25 | 31 | 24 | 161·1 | 1 | 60·1 | 25 | 163·5 | 27 | 24·2 | 14 | 1·18 | 14 |
| October .. .. | 29·046 | 11 | ·741 | 24 | ·305 | 97·1 | 1 | 68·3 | 30 | 65·0 | 2 | 33 | 1 | 159·6 | 3 | 62·3 | 2 | 95·8 | 1 | 15·0 | 30 | 1·71 | 27 |
| November .. .. | ·100 | 24 | ·717 | 3 | ·283 | 89·8 | 30 | 59·5 | 12 | 56·8 | 11&12 | 24 | 11 | 144·6 | 23 | 49·8 | 12 | 60·3 | 14 | **8·7** | 1 | 0·21 | 1 |
| December .. .. | ·152 | 10 | ·807 | 31 | ·345 | 90·8 | 23 | 57·2 | 9 | 54·3 | 9 | 31 | 11 | 146·8 | 21 | 48·2 | 9 | 72·7 | 12 | 14·9 | 5 | 0·07 | 26 |

# Appendix VII.

MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1908.

| Abnormals of | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure .. .. .. | + 0·020 | − 0·035 | + 0·019 | − 0·041 | Same as | − 0·010 | + 0·017 | − 0·022 | − 0·024 | − 0·008 | − 0·005 | + 0·003 | − 0·007 |
| Temperature of air .. .. .. .. .. | + 0·8 | + 0·2 | + 0·2 | + 1·3 | + 1·7 | + 1·8 | + 1·1 | + 0·6 | − 0·8 | + 0·5 | − 1·6 | − 0·5 | + 0·4 |
| Do. of evaporation .. .. .. | + 2·3 | + 1·5 | Same as | + 2·2 | + 1·6 | + 1·4 | + 1·9 | + 1·9 | + 2·5 | + 1·6 | − 1·7 | − 1·0 | + 1·2 |
| Percentage of humidity .. .. .. .. | + 6 | + 6 | − 1 | + 3 | + 2 | Same as | + 5 | + 5 | + 14 | + 5 | Same as | − 2 | + 3 |
| Greatest solar heat in *vacuo* .. .. .. .. | − 5·5 | − 4·6 | − 4·3 | − 1·5 | − 0·7 | − 2·5 | − 7·3 | − 6·4 | − 8·5 | − 8·2 | − 9·7 | − 9·0 | − 5·7 |
| Maximum in shade .. .. .. .. .. | − 0·2 | − 0·1 | + 0·5 | + 2·8 | + 2·8 | + 3·9 | + 1·0 | + 1·5 | − 2·4 | + 0·4 | − 1·1 | − 1·2 | + 0·7 |
| Minimum in shade .. .. .. .. .. | + 0·8 | + 0·2 | − 0·9 | + 1·3 | + 0·9 | + 1·8 | + 1·2 | − 0·2 | ... 0·6 | − 0·5 | − 3·3 | − 1·4 | Same as |
| Do. on grass .. .. .. .. .. | + 2·0 | + 1·1 | − 0·3 | + 2·2 | + 1·5 | + 2·2 | + 1·7 | + 0·9 | + 0·2 | − 0·4 | − 3·5 | − 1·3 | + 0·6 |
| Rainfall in inches .. .. .. .. .. | − 0·87 | + 0·20 | − 0·39 | − 0·62 | − 2·03 | − 1·63 | − 2·25 | + 0·14 | + 4·82 | + 13·78 | − 1·20 | − 3·00 | + 6·95 |
| Do. since January .. .. .. .. | .. | − 0·67 | − 1·06 | − 1·68 | − 3·71 | − 5·34 | − 7·59 | − 7·45 | − 2·63 | + 11·15 | + 9·95 | + 6·95 | .. |
| General direction of wind .. .. .. .. | 1 point E. | 1 point S. | Same as | 1 point S. | 1 point S. | Same as | 1 point W. | 1 point S. | 1 point W. | 3 points S. | Same as | 1 point E. | Same as |
| Daily velocity in miles .. .. .. .. | − 36 | − 34 | − 60 | − 28 | − 49 | − 35 | − 59 | − 57 | − 69 | − 28 | − 35 | − 2 | − 41 |
| Percentage of cloudy sky .. .. .. .. | − 8 | + 2 | + 3 | − 3 | − 3 | − 4 | + 5 | − 1 | − 5 | − 11 | − 19 | − 8 | − 5 |
| Do. of bright sunshine .. .. .. | − 11·1 | − 21·9 | − 15·5 | − 4·7 | − 15·1 | − 12·3 | − 11·6 | − 15·8 | − 3·6 | − 3·8 | − 0·8 | − 7·7 | − 9·7 |

+ means *above* normal, − *below*.

# Appendix VIII.

Abstract of the mean meteorological condition of Madras in the year 1908 compared with the average of past years.

| Mean values of | 1908. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure .. .. .. .. .. .. | 29·857 | 0·007 below. | 29·864 |
| Temperature of air .. .. .. .. .. .. .. | 81·5 | 0·4 above. | 81·1 |
| Do. of evaporation .. .. .. .. .. .. | 75·7 | 1·2 ,, | 74·5 |
| Percentage of humidity .. .. .. .. .. .. | 75 | 3 ,, | 72 |
| Greatest solar heat in *vacuo* .. .. .. .. .. .. | 134·0 | 5·7 below. | 139·7 |
| Maximum in shade .. .. .. .. .. .. .. | 91·5 | 0·7 above. | 90·8 |
| Minimum in shade .. .. .. .. .. .. .. | 74·7 | Same as | 74·7 |
| Do. on grass .. .. .. .. .. .. .. | 72·5 | 0·6 above. | 71·9 |
| Rainfall in inches on 88 days .. .. .. .. .. .. | 55·97 | 6·95 ,, | 49·02 |
| General direction of wind .. .. .. .. .. .. | S.E. | Same as | S.E. |
| Daily velocity in miles .. .. .. .. .. .. .. | 130 | 41 below. | 171 |
| Percentage of cloudy sky .. .. .. .. .. .. | 44 | 5 ,, | 49 |
| Do. of bright sunshine .. .. .. .. .. .. | 48·7 | 9·7 ,, | 58·4 |

Duration and quantity of the wind from different points.

| From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North .. | 102 | 646 | East .. | 178 | 872 | South .. | 265 | 1,608 | West .. | 331 | 2,630 |
| N. by E. .. | 321 | 1,798 | E. by S. .. | 286 | 1,128 | S. by W... | 282 | 1,370 | W. by N... | 150 | 1,114 |
| N.N.E. .. | 324 | 1,938 | E.S.E. .. | 326 | 1,368 | S.S.W. .. | 272 | 1,480 | W.N.W. .. | 117 | 819 |
| N.E. by N... | 464 | 3,320 | S.E. by E. | 264 | 1,377 | S.W. by S. | 173 | 698 | N.W. by W. | 54 | 367 |
| N.E. .. | 237 | 1,602 | S.E. .. | 556 | 3,342 | S.W. .. | 165 | 833 | N.W. .. | 53 | 340 |
| N.E. by E. | 235 | 1,582 | S.E. by S. | 610 | 4,528 | S.W. by W. | 176 | 862 | N.W. by N. | 60 | 297 |
| E.N.E. .. | 177 | 915 | S.S.E. .. | 453 | 3,020 | W.S.W. .. | 291 | 1,621 | N.N.W. .. | 106 | 600 |
| E. by N. .. | 167 | 1,064 | S. by E. .. | 342 | 1,855 | W. by S... | 274 | 1,701 | N. by W... | 187 | 998 |

There were 786 calm hours during the year. The resultant corresponding to the above numbers is represented by a S.E. wind, blowing with a uniform daily velocity of 27 miles.

# Appendix IX.

MADRAS OBSERVATORY.—Number of hours of wind from each point in the year 1908.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. .. .. | .. | 16 | 61 | 94 | 72 | 49 | 42 | 40 | 87 | 71 | 56 | 22 | 30 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 104 |
| February .. .. .. .. | .. | .. | 1 | 12 | 27 | 62 | 47 | 60 | 7 | 89 | 76 | 36 | 20 | 14 | 24 | 57 | 3 | 12 | 3 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 146 |
| March .. .. .. .. | .. | .. | .. | .. | .. | .. | 9 | 6 | 33 | 54 | 93 | 41 | 137 | 99 | 14 | 38 | 10 | 10 | 9 | 1 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 189 |
| April .. .. .. .. | .. | .. | .. | .. | .. | .. | 1 | .. | 1 | 5 | 9 | 24 | 119 | 231 | 99 | 33 | 49 | 28 | 36 | 6 | 7 | 4 | 6 | .. | 3 | 3 | 1 | 1 | 2 | .. | 1 | .. | 51 |
| May .. .. .. .. | 1 | .. | 3 | 1 | .. | 6 | 1 | 1 | 1 | .. | 4 | 16 | 98 | 98 | 128 | 56 | 85 | 54 | 39 | 11 | 22 | 10 | 16 | 6 | 21 | 8 | 17 | 2 | 9 | 1 | 8 | 3 | 18 |
| June .. .. .. .. | 1 | .. | 2 | 4 | 3 | 1 | 3 | 5 | 4 | 4 | 8 | 14 | 34 | 31 | 61 | 26 | 39 | 32 | 52 | 37 | 25 | 23 | 52 | 55 | 98 | 33 | 27 | 18 | 11 | 3 | 1 | 3 | 10 |
| July .. .. .. .. | .. | .. | .. | .. | .. | 1 | .. | 1 | .. | 1 | 6 | 8 | 9 | 21 | 14 | 37 | 16 | 52 | 25 | 35 | 31 | 55 | 115 | 84 | 113 | 46 | 12 | 6 | 6 | 2 | 2 | 1 | 45 |
| August .. .. .. .. | .. | 1 | 1 | .. | 1 | .. | 2 | 5 | 3 | 5 | 9 | 25 | 11 | 58 | 46 | 57 | 29 | 59 | 55 | 49 | 33 | 40 | 29 | 70 | 42 | 37 | 16 | 7 | 5 | 2 | 1 | .. | 46 |
| September .. .. .. .. | .. | 1 | 2 | 1 | 1 | .. | 3 | 8 | 2 | 4 | 16 | 25 | 32 | 31 | 39 | 28 | 22 | 22 | 44 | 27 | 41 | 32 | 43 | 28 | 39 | 16 | 36 | 17 | 10 | 20 | 5 | .. | 125 |
| October .. .. .. .. | 29 | 38 | 18 | 19 | 12 | 13 | 41 | 28 | 40 | 46 | 48 | 38 | 66 | 27 | 11 | 9 | 11 | 13 | 9 | 5 | 4 | 11 | 30 | 29 | 15 | 5 | 7 | 3 | 6 | 7 | 31 | 35 | 40 |
| November .. .. .. .. | 36 | 114 | 92 | 141 | 35 | 24 | 16 | 6 | .. | 7 | 1 | 15 | .. | .. | 17 | 1 | 1 | .. | .. | 2 | 1 | 1 | .. | 2 | .. | 2 | 1 | .. | 4 | 25 | 51 | 113 | 12 |
| December .. .. .. .. | 35 | 151 | 144 | 192 | 86 | 79 | 12 | 7 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 6 | 32 | .. |
| Annual .. | 102 | 321 | 324 | 464 | 237 | 235 | 177 | 167 | 178 | 286 | 326 | 264 | 556 | 610 | 453 | 342 | 265 | 252 | 272 | 173 | 165 | 176 | 291 | 274 | 331 | 150 | 117 | 54 | 53 | 60 | 106 | 187 | 786 |

# Appendix X.

MADRAS OBSERVATORY.—Number of miles of wind from each point in the year 1908.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. .. .. | .. | 89 | 382 | 628 | 403 | 214 | 204 | 232 | 402 | 216 | 226 | 191 | 146 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3333 |
| February .. .. .. .. | .. | .. | 5 | 78 | 121 | 359 | 259 | 410 | 57 | 341 | 285 | 126 | 69 | 78 | 84 | 201 | 19 | 52 | 17 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2561 |
| March .. .. .. .. .. | .. | .. | .. | .. | .. | .. | 26 | 54 | 191 | 199 | 413 | 275 | 655 | 597 | 88 | 157 | 70 | 70 | 50 | 7 | 2 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2854 |
| April .. . .. .. .. | .. | .. | .. | .. | .. | .. | 11 | .. | 5 | 6 | 38 | 100 | 838 | 1876 | 748 | 179 | 337 | 220 | 287 | 43 | 61 | 24 | 37 | .. | 31 | 17 | 6 | 10 | 16 | .. | 10 | .. | 4900 |
| May .. .. .. .. .. | 12 | .. | 29 | 8 | .. | 62 | 9 | 9 | 3 | .. | 35 | 123 | 890 | 906 | 1000 | 392 | 519 | 266 | 218 | 71 | 141 | 82 | 87 | 39 | 189 | 66 | 171 | 21 | 79 | 8 | 61 | 31 | 5527 |
| June .. .. .. .. .. | 3 | .. | 14 | 34 | 19 | 13 | 22 | 29 | 29 | 28 | 60 | 122 | 291 | 311 | 547 | 235 | 291 | 203 | 298 | 215 | 146 | 134 | 348 | 457 | 894 | 289 | 232 | 155 | 95 | 9 | 1 | 20 | 5544 |
| July .. .. .. .. .. | .. | .. | .. | .. | .. | 7 | .. | 2 | .. | 8 | 37 | 42 | 62 | 142 | 99 | 217 | 62 | 221 | 112 | 104 | 187 | 283 | 672 | 553 | 946 | 373 | 84 | 44 | 27 | 9 | 2 | 1 | 4296 |
| August .. .. .. .. | .. | 5 | 6 | .. | 6 | .. | 12 | 29 | 15 | 20 | 38 | 129 | 41 | 333 | 251 | 292 | 160 | 206 | 259 | 136 | 129 | 177 | 161 | 432 | 286 | 277 | 123 | 41 | 21 | 11 | 15 | .. | 3611 |
| September .. .. .. .. | .. | 5 | 14 | 5 | 6 | .. | 14 | 46 | 6 | 26 | 54 | 39 | 151 | 170 | 128 | 155 | 101 | 82 | 193 | 97 | 140 | 119 | 205 | 118 | 223 | 60 | 157 | 89 | 50 | 65 | 28 | .. | 2596 |
| October .. .. .. .. | 127 | 181 | 73 | 96 | 51 | 53 | 149 | 144 | 164 | 248 | 179 | 150 | 199 | 115 | 41 | 22 | 47 | 50 | 46 | 17 | 23 | 39 | 111 | 99 | 61 | 24 | 39 | 7 | 31 | 25 | 152 | 175 | 2938 |
| November .. .. .. .. | 217 | 634 | 541 | 793 | 215 | 170 | 94 | 40 | .. | 36 | 3 | 30 | .. | .. | 34 | 5 | 2 | .. | .. | 8 | 4 | 4 | .. | 3 | .. | 8 | 7 | .. | 21 | 170 | 304 | 565 | 3908 |
| December .. .. .. .. | 287 | 884 | 874 | 1678 | 781 | 704 | 115 | 69 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 27 | 206 | 5625 |
| Annual .. | 646 | 1798 | 1938 | 3320 | 1602 | 1582 | 915 | 1064 | 872 | 1128 | 1368 | 1377 | 3342 | 4528 | 3020 | 1855 | 1608 | 1370 | 1480 | 698 | 833 | 862 | 1621 | 1701 | 2630 | 1114 | 819 | 367 | 340 | 297 | 600 | 998 | 47693 |

# Appendix XI.

Madras Observatory.—Number of inches of rain from each point in the year 1908.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·02 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| February .. .. .. | .. | .. | .. | .. | .. | .. | 0·02 | 0·06 | .. | 0·26 | 0·14 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| March .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| April .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| May .. . .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·02 | .. | .. | 0·07 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| June .. .. .. | .. | .. | .. | .. | 0·09 | .. | 0·02 | 0·03 | 0·01 | .. | .. | .. | 0·02 | 0·01 | 0·05 | 0·04 | .. | 0·01 | .. | .. | 0·01 | .. | .. | 0·04 | 0·06 | 0·02 | 0·01 | .. | .. | .. | .. | 0·04 | 0·02 |
| July .. .. .. | .. | .. | .. | .. | .. | .. | .. | 0·05 | .. | .. | .. | .. | . | .. | 0·01 | 0·01 | 0·02 | 0·09 | 0·11 | 0·07 | 0·02 | 0·27 | 0·15 | 0·01 | 0·23 | 0·07 | 0·12 | 0·19 | 0·05 | .. | .. | .. | 0·15 |
| August .. .. .. | .. | .. | .. | .. | 0·06 | .. | .. | .. | .. | 0·09 | 0·40 | .. | .. | 0·51 | .. | .. | .. | 0·17 | 0·62 | 0·50 | 0·64 | .. | 0·23 | 0·11 | 0·24 | .. | 0·03 | 0·10 | 0·10 | .. | 0·05 | .. | 0·85 |
| September .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·23 | .. | .. | 0·06 | .. | .. | 0·15 | 0·18 | 0·19 | 1·17 | 1·42 | 0·96 | 0·01 | 1·56 | 0·14 | 0·44 | 1·61 | 0·66 | 0·22 | 0·17 | .. | 0·34 |
| October .. .. .. | 0·56 | 4·08 | 1·12 | 1·48 | 0·69 | 0·16 | 0·92 | 0·11 | 0·11 | 0·14 | 0·38 | 0·08 | 0·39 | 1·25 | 2·32 | .. | .. | .. | .. | .. | .. | 0·08 | 0·10 | 0·02 | .. | .. | 2·17 | 0·32 | 0·86 | 1·86 | 4·36 | 1·22 | .. |
| November .. .. | 0·57 | 1·53 | 1·16 | 0·16 | 0·83 | 0·05 | 0·31 | 0·10 | .. | 0·12 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·50 | 0·38 | .. | 0·83 | 0·57 | 3·25 | 1·65 | .. |
| December .. .. | 0·03 | 0·46 | 0·10 | 0·39 | 0·46 | 0·60 | 0·17 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·07 | .. |
| Annual .. | 1·16 | 6·07 | 2·38 | 2·03 | 2·13 | 0·81 | 1·44 | 0·35 | 0·14 | 0·61 | 0·92 | 0·31 | 0·41 | 1·77 | 2·44 | 0·07 | 0·02 | 0·42 | 0·98 | 0·76 | 1·84 | 1·77 | 1·44 | 0·19 | 2·09 | 0·73 | 3·15 | 2·22 | 2·50 | 2·65 | 7·83 | 2·98 | 1·36 |

# Appendix XII.

Madras Observatory.—Wind, cloud, and bright sunshine, 1908.

| Month. | Wind resultant. | | Clouds (0—10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H. | 16 H. | 20 H. | Mean. | Average per day. | Greatest number of hours in a day. |
| | MILES. | | | | | | | HOURS. | |
| January .. .. .. .. | 88 | E.N.E. | 3·5 | 4·0 | 2·0 | 2·1 | 2·9 | 7·2 | 9·3 |
| February .. .. .. | 68 | E. | 2·7 | 3·0 | 2·6 | 2 0 | 2·6 | 8·1 | 9·8 |
| March .. .. .. .. | 83 | S.E. | 2·8 | 3·4 | 2·6 | 1·9 | 2·7 | 7·6 | 9·9 |
| April .. .. .. .. | 145 | S.S.E. | 4·0 | 3·0 | 1·8 | 1·2 | 2·5 | 8·4 | 11·0 |
| May .. .. .. .. | 152 | S. by E. | 3·6 | 3·4 | 3·8 | 3·0 | 3·5 | 6·6 | 8·5 |
| June .. .. .. .. | 98 | S.W. | 6·0 | 5·6 | 6·3 | 6·2 | 6·0 | 4·4 | 7·4 |
| July .. .. .. .. | 101 | S.W. by W. | 7·6 | 7·3 | 7·5 | 7·7 | 7·6 | 2·6 | 7·5 |
| August .. .. .. .. | 45 | S.W. by S. | 6·5 | 6·3 | 7·4 | 5·9 | 6·6 | 3·2 | 8·7 |
| September .. .. .. | 42 | S.W. by S. | 6·3 | 5·5 | 5·9 | 5·1 | 5·7 | 4·9 | 9·8 |
| October .. .. .. .. | 29 | E. by N. | 4·1 | 4·5 | 5·6 | 4·9 | 4·8 | 5·7 | 10·4 |
| November .. .. .. | 111 | N. by E. | 3·7 | 4·4 | 4·5 | 3·1 | 4·0 | 6·2 | 9·9 |
| December .. .. .. | 172 | N.E. by N. | 4·4 | 4·8 | 4·5 | 3·8 | 4·4 | 5·6 | 8·3 |
| Annual .. | 27 | S.E. | 4·6 | 4·6 | 4·5 | 3·9 | 4·4 | 5·9 | .. |

# Appendix XIII.

MEAN monthly and annual Meteorological Results at the Madras Observatory in 1908.

| — | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer. Mean. | Dry bulb thermometer. Max. | Dry bulb thermometer. Min. | Dry bulb thermometer. Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. By Blanford's tables. | Relative humidity. | Sun Max. *in vac.* | Min. on grass. | Wind. Daily velocity. | Wind. Mean direction. | | Rain. Amount. | Rain. Days. | Cloudy sky. | Bright sunshine. | Dew point. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | PTS. | | INCHES. | NO. | CENTS. | HOURS. | ° |
| January .. .. .. | 30·017 | 0·123 | 75·9 | 84·4 | 68·3 | 16·1 | 71·5 | 68·0 | 0·679 | 79 | 132·9 | 65·1 | 108 | 6 | E. N. E. | 0·02 | 1 | 29 | 221·5 | 68·2 |
| February .. .. .. | 29·930 | ·120 | 76·0 | 86·4 | 68·2 | 18·3 | 72·3 | 67·8 | ·733 | 79 | 135·1 | 64·9 | 88 | 9 | E. by. S. | 0·48 | 4 | 26 | 235·9 | 69·1 |
| March .. .. .. | ·924 | ·121 | 80·2 | 90·1 | 71·2 | 18·9 | 73·9 | 70·4 | ·758 | 73 | 136·2 | 68·3 | 92 | 12 | S. E. | .. | .. | 27 | 235·6 | 69·6 |
| April .. .. .. | ·785 | ·131 | 85·3 | 95·7 | 78·5 | 17·2 | 79·8 | 77·2 | ·945 | 77 | 140·2 | 76·9 | 163 | 14 | S. S. E. | .. | .. | 25 | 252·3 | 76·1 |
| May .. .. .. | ·735 | ·119 | 88 4 | 100·6 | 81·7 | 18·9 | 79·9 | 77·1 | ·910 | 69 | 142·3 | 80·4 | 178 | 16 | South | 0·09 | 2 | 35 | 205·7 | 74·5 |
| June .. .. .. | ·693 | ·116 | 88·2 | 102·2 | 82·1 | 20·1 | 78·0 | 75·1 | ·823 | 62 | 138·0 | 80·8 | 185 | 19 | S.W.by S. | 0·48 | 9 | 60 | 132·0 | 71·5 |
| July .. .. .. | ·738 | ·123 | 85·6 | 96·6 | 79·7 | 16·9 | 77·8 | 75·1 | ·849 | 70 | 131·4 | 78·3 | 139 | 21 | S.W.by W. | 1·62 | 18 | 76 | 81·0 | 72·7 |
| August .. .. .. | ·737 | ·130 | 83·9 | 95·2 | 77·7 | 17·5 | 77·9 | 74·9 | ·874 | 75 | 133·6 | 76·3 | 117 | 18 | S. S. W. | 4·70 | 12 | 66 | 97·6 | 73·9 |
| September .. .. .. | ·753 | ·126 | 82·2 | 90·8 | 76·5 | 14·3 | 78·8 | 75·7 | ·940 | 86 | 132·8 | 75·2 | 87 | 19 | S.W. by S. | 9·61 | 19 | 57 | 146·9 | 76·5 |
| October .. .. .. | ·834 | ·120 | 81·1 | 89·4 | 74·7 | 14·7 | 77·2 | 73·8 | ·884 | 83 | 130·9 | 72·4 | 95 | 10 | F. S. E. | 24·78 | 11 | 48 | 177·0 | 74·5 |
| November .. .. .. | ·919 | ·114 | 75·9 | 83·9 | 69·0 | 14·9 | 71·2 | 68·1 | ·706 | 79 | 127·7 | 66·0 | 130 | 2 | N. N. E. | 12 01 | 8 | 40 | 187·0 | 67·9 |
| December .. .. .. | ·981 | ·109 | 75·0 | 82·4 | 68·4 | 14·0 | 69·6 | 67·0 | ·654 | 75 | 126·8 | 65·1 | 181 | 3 | N.E. by N. | 2·28 | 4 | 44 | 173·3 | 65·7 |
| Annual .. | 29·836 | ·121 | 81·5 | 91·5 | 74·7 | 16·8 | 75·7 | 72·5 | ·813 | 75 | 134·0 | 72·5 | 130 | 12 | S. E. | 55·97 | 88 | 44 | 2,145·8 | 71·9 |

EXTREME monthly Meteorological Records at the Madras Observatory in 1908.

| — | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry bulb thermometer. Highest. | | Dry bulb thermometer. Lowest. | | Wet bulb. Lowest. | | Humidity. Lowest. | | Sun Th. *in vacuo.* Highest. | | Grass therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY. |
| January .. .. .. | 30·176 | 8 | 29·805 | 31 | 0·371 | 87·9 | 29 | 60·8 | 20 | 60·3 | 20 | 41 | 29 | 137·9 | 8 | 57·1 | 20 | 199 | 1 | 27 | 28 | 0·02 | 17 |
| February .. .. .. | ·141 | 8 | ·792 | 29 | ·349 | 92·3 | 16 | 63·9 | 12 | 63·9 | 12 | 51 | 5 | 141·2 | 16 | 59·3 | 12, 14 | 178 | 8 | 39 | 3 | 0·25 | 22 |
| March .. .. .. | ·096 | 12 | ·758 | 31 | ·338 | 97·5 | 10 | 62·5 | 9 | 60·3 | 9 | 13 | 8 | 143·4 | 8 | 57·5 | 9 | 145 | 15 | 45 | 4 | .. | .. |
| April .. .. .. | 29·934 | 13 | ·608 | 27 | ·326 | 109·6 | 26 | 75·1 | 1 | 74·5 | 1 | 38 | 27, 28 | 150·1 | 27 | 72·3 | 1 | 247 | 29 | 105 | 13 | .. | .. |
| May .. .. .. | ·889 | 2 | ·591 | 9 | ·298 | 109·6 | 30 | 78·0 | 2 | 72·3 | 14 | 30 | 15 | 154·0 | 11 | 75·9 | 31 | 227 | 25 | 113 | 8 | 0·07 | 30 |
| June .. .. .. | ·795 | 3 | ·569 | 29 | ·226 | 107·5 | 1 | 77·2 | 28 | 71·6 | 16 | 28 | 25 | 145·7 | 2 | 75·2 | 28 | 244 | 16 | 133 | 28 | 0·11 | 17,30 |
| July .. .. .. | ·860 | 9 | ·573 | 27 | ·287 | 101·1 | 3 | 73·3 | 11 | 71·8 | 11 | 38 | 1,2 | 144·6 | 20 | 72·0 | 11 | 189 | 22 | 39 | 12 | 0·25 | 19 |
| August .. .. .. | ·848 | 25 | ·589 | 2 | ·259 | 98·9 | 17 | 71·6 | 25 | 71·5 | 25 | 38 | 15 | 145·0 | 18 | 71·0 | 25 | 166 | 1 | 51 | 8 | 1·40 | 6 |
| September .. .. .. | ·882 | 15 | ·597 | 28 | ·285 | 98·2 | 2 | 73·9 | 22 | 72·7 | 17, 18 | 59 | 28 | 146·0 | 1 | 70·2 | 18 | 206 | 26 | 28 | 15 | 1·28 | 22 |
| October .. .. .. | ·969 | 11 | ·676 | 1 | ·293 | 96 6 | 2 | 70·1 | 12 | 69·7 | 12 | 51 | 14 | 144·7 | 8 | 65·9 | 12 | 205 | 24 | 54 | 6 | 7·28 | 23 |
| November .. .. .. | 30·061 | 24 | ·636 | 2 | ·425 | 87·4 | 10 | 65·0 | 10 | 64·5 | 10, 15 | 40 | 15 | 137·2 | 22 | 60·1 | 10 | 228 | 30 | 51 | 11 | 6·58 | 2 |
| December .. .. .. | ·132 | 13 | ·812 | 31 | ·320 | 85·4 | 25 | 62·4 | 8 | 61·9 | 8 | 49 | 11 | 137·1 | 8 | 58·7 | 8 | 366 | 31 | 122 | 25 | 1·72 | 31 |

# KODAIKÁNAL AND MADRAS OBSERVATORIES.

## REPORT FOR THE YEAR 1909.

### CONTENTS.

# KODAIKÁNAL AND MADRAS OBSERVATORIES.

## I.—REPORT OF THE KODAIKÁNAL OBSERVATORY FOR THE YEAR 1909.

1. **Staff.**—The staff of the observatory on the 31st December 1909 was as follows :—

| | |
|---|---|
| Director .. .. .. .. | C. Michie Smith, B.Sc. |
| Assistant Director .. .. .. | J. Evershed. |
| First Assistant .. .. .. | S. Sitarama Aiyar, B.A. |
| Second Assistant .. .. .. | G. Nagaraja Aiyar. |
| Third Assistant .. .. .. | A. Y. Subrahmanya Aiyar, B.A. |
| Fourth Assistant .. .. .. | S. Balasundaram Aiyar. |
| Writer .. .. .. .. | L. N. Krishnaswami Aiyar. |
| Photographic Assistant .. .. | R. Krishna Aiyar. |

The first assistant, M.R.Ry. K. V. Sivarama Aiyar Avargal, M.A., B.L., retired from the service on medical certificate on February 12. He had done much valuable work during his service of 15 years in the Madras and Kodaikánal Observatories and it was with great regret that the decision of the medical authorities that he could not again return to work was accepted. Mr. S. Sitarama Aiyar, Mr. G. Nagaraja Aiyar, and Mr. A. Y. Subrahmanya Aiyar were respectively confirmed as first, second, and third assistants. The first assistant was on privilege leave for 40 days from July 26, the second assistant for 1 month and 2 days from October 18, and the fourth assistant for 17 days from March 4, and for 41 days from November 12.

The subordinate staff consists of a book-binder, a book-binder's boy, a mechanic, five peons, a boy peon for the dark room, and two lascars.

2. **Distribution of work.**—The Director is in charge of the 40-foot spectrograph and the pyrheliometer; the Assistant Director is in charge of the spectroheliograph and associated instruments. The first, second, and third assistants are in charge of the work with the Cooke equatorial (spectroscopic), the Lerebour and Secretan equatorial (visual), the photoheliograph, the transit instrument, and the seismometer. They have also to do the astronomical computing and the preparation of the observations for the press. The fourth assistant has charge of the clock comparisons and, with the help of the writer, is responsible for the whole of the meteorological work. The writer is responsible for the accounts, correspondence, and all office records. The photographic assistant has charge of most of the photographic developing, printing, etc.

3. **Buildings and grounds.**—From April 1 the responsibility for all the minor repairs to the buildings, fences, etc., was transferred from the Public Works Department to the Director and an annual grant will be made for the purpose. This, while involving a considerable amount of extra work, renders it much easier to keep all the buildings in good repair and is certainly an economical arrangement.

(*a*) *Spectroheliograph building.*—The roof of the main building has been covered with ruberoid and is now in a satisfactory condition. Two new piers have been built in it for carrying a new spectrograph (No. III.).

(*b*) *Grounds.*—A large number of pine and cypress trees have been planted to the east of the spectroheliograph building where the ground is at present very bare, and it is hoped that enough of seedlings will be available during the current year to complete the planting of this area.

The trees formerly planted in various parts of the compound are making good progress and are already exercising a most valuable influence on the observing conditions. The plantation surrounding the Observatory compound on the west and north-west was burned down on January 26, for the second time, and the Observatory compound was protected from the flames only by the strenuous exertions of the staff. A beginning has been made in planting a screen of wattle round the part of the compound most exposed to fire and it is hoped that when this grows up it will greately reduce the risk.

4. **Instruments.**—The following are the principal instruments belonging to the Observatory, or in use, at the present time :—

Six-inch Cooke equatorial.
Six-inch Lerebour and Secretan equatorial remounted by Grubb with a five-inch Grubb portrait lens of 36 inches focus attached.
Spectograph I.—consisting of slit, collimator lens of 4 or 7 feet focus, 2-inch parabolic grating, and camera tube without lens. Used in connection with an 11-inch polar siderostat and 6-inch Grubb lens of 40 feet focus.
A rhomb with ends cut at 45° mounted on a graduated circle can be placed in front of the slit so as to enable any part of the limb to be brought on to the slit.
Spectrograph II.—consisting of slit, collimator lens of 3 feet focus, 3-inch plane grating and camera lens of 7 feet focus. Used in connection with the 12-inch photo-visual lens of the spectroheliograph.
Spectroheliograph—with 18-inch siderostat and 12-inch Cooke photo-visual lens of 20 feet focus, by the Cambridge Scientific Instrument Company.
An auxiliary spectroheliograph attached to the above, made in the Observatory workshop.
Six-inch transit instrument and barrel chronograph, formerly the property of the Survey of India.
Six-prism table spectroscope—Hilger.
Photoheliograph Dallmeyer No. 4.
Theodolite, six-inch—Cooke.
Two phototheodolites by Steinheil, for cloud photography.
Sextant.
Evershed spectroscope with three prisms for prominence and sunspot work, by Hilger.
Mean time clock, Kullberg 6326.
    Do.    Shelton.
Mean time Chronometer, Kullberg 6299.
Sidereal chronometer, Kullberg 6134.
Tape chronograph, Fuess.
Micrometer for measuring spectrum photographs, Hilger.
Dividing engine, Cambridge Scientific Instrument Company, Limited
Two Balfour Stewart actinometers.
Buchanan's solar calorimeter
Induction coil with necessary adjuncts.
Small polar siderostat.
Universal instrument.
Complete set of meteorological instruments, including Richard barograph and thermograph, and wind recorders.
A high class screw cutting turning lathe by Messers. Cooke & Sons.
Ångström Pyrheliometer.
Single meniscus lens 5″ aperture, 15-feet focus.
An 18-inch concave mirror by Henry of Paris belonging to the Assistant Director has been mounted in the spectroheliograph room for general spectrum work and for large scale photographs of sunspots.
Spectrograph III.—consisting of slit provided with vertical and horizontal millimetre scales for measuring position angles and a reflecting device for rotating the sun's image, collimator lens of 210 c.m focus, 6 inch Michelson grating, and camera lens of about 4 metres focus. The spectrograph is used with the 18-inch concave mirror.

The Observatory was struck by lightning twice during the year, on March 29 and in May and considerable damage was done to the electrical instruments. On the first occasion the flash apparently entered by the telegraph line and, though part of it went to earth through the lightning discharger, enough remained to splash on to the internal circuits. It stopped the standard clock through the fusing of the seconds contacts, fused the coils of one of the relays and several bells, and injured the telephones. The wire leading to the spectroheliograph house was fused where it came near the branch of a tree.

On the second occasion the only damage done was to a bell circuit. New and more sensitive lightning dischargers have now been placed on the main circuits.

## OBSERVATIONS.

### (*a*) Solar Physics.

5. The following table shows for each day the solar observations that were made:—

# Table A.

## Solar Observations in 1909.

A = Spots observed. B = Spot spectra. C = Prominences. D = Photoheliograms. E = Spectroheliograms.

| Date. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 .. | — | ABCDE | A—CDE | A—CDE | A—*C*DE | A—*C*D*E* | A———— | A———— | A——D*E* | A—*C*D*E* | A—*C*DE | ABCDE |
| 2 .. | — | ABCDE | A—*C*D*E* | ABCDE | A—*C*DE | A—*C*D*E* | A——D*E* | A—*C*DE | A———— | A—*C*DE | A—CDE | AB*C*DE |
| 3 .. | — | AB*C*DE | ABCDE | AB*C*DE | A———— | A———— | A—CD*E* | A—CDE | ————— | A——D | A—CDE | A—CDE |
| 4 .. | A—*C*D*E* | ABCDE | A—CDE | A—*C*DE | — | — | A—*C*DE | A—*C*D*E* | A—*C*D*E* | A—CDE | A———— | A—CDE |
| 5 .. | ABCDE | AB*C*DE | ABCDE | ABCDE | A—*C*D*E* | A———— | A—CDE | A—CDE | A—CDE | A—CDE | AB*C*DE | A—*C*DE |
| 6 .. | AB——*E* | ABCDE | ABCDE | ABCDE | — | A——D— | A—*C*DE | A—*C*D*E* | A—CDE | A—CDE | ABCDE | A—CDE |
| 7 .. | ABCDE | A—CDE | A—CDE | A—CDE | — | A———— | A———— | A—CDE | A——D*E* | A—*C*DE | A*B*CDE | A—CDE |
| 8 | ABCDE | A—CDE | A——D*E* | ABCDE | A—CDE | A—*C*DE | A——D— | A—*C*DE | A—*C*DE | A—*C*DE | A—*C*DE | ————— |
| 9 . | A—CDE | A—*C*DE | A—CDE | A—CDE | AB*C*DE | ABCDE | A——D— | A—*C*DE | ABCDE | A—*C*DE | A—*C*D*E* | A—CDE |
| 10 .. | ABCDE | A—CDE | A—CDE | A—*C*DE | ABCDE | A*B*CDE | A—*C*D*E* | A—CDE | A—*C*DE | A—*C*DE | A—CD | A—CD*E* |
| 11 .. | A—CDE | A—CDE | A—CDE | A—CDE | ABCDE | A—*C*DE | A—*C*D*E* | A—CDE | AB*C*DE | AB*C*DE | A—CDE | A—CDE |
| 12 .. | ABCDE | A—CDE | ABCDE | A—*C*DE | AB*C*DE | A—CDE | — | A—*C*DE | A—*C*DE | A—*C*D*E* | A—CDE | A—*C*D*E* |
| 13 .. | ABCDE | A—CDE | A—CDE | A—CDE | AB*C*DE | A—CDE | A——D— | A——D— | A—CDE | A—CDE | A—CDE | A——D— |
| 14 .. | A—CDE | A—CDE | A—CDE | A—CDE | A—*C*D*E* | A—CDE | A——D*E* | A—CD*E* | A—*C*DE | A*B*CDE | ABCDE | A—*C*DE |
| 15 .. | ABCDE | A—CDE | A—CDE | A—CDE | AB*C*DE | A—CDE | A———— | ———— | A—CDE | A—*C*D*E* | A—CDE | A—CDE |
| 16 .. | ABCDE | ABCDE | A—CDE | A—CDE | A—CDE | A——DE | A—*C*DE | A—*C*DE | A—CDE | A—*C*DE | A—*C*DE | ABCDE |
| 17 .. | AB*C*DE | A—CDE | A—CDE | A—CDE | ABCDE | A*B*CDE | A——DE | A—CDE | A——D*E* | A——D*E* | A—*C*DE | ABCDE |
| 18 .. | A—CDE | A—*C*DE | A—CDE | A—*C*DE | A—*C*DE | ABCDE | A—CDE | A—CDE | A—CDE | ————— | A—*C*DE | A—*C*DE |
| 19 .. | A—*C*D*E* | A—CD*E* | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | A—*C*D*E* | A—*C*DE | ABCDE |
| 20 .. | ABCDE | A—*C*D*E* | A—CDE | A—CDE | A—CDE | A—CD*E* | ABCDE | A—*C*DE | ABCDE | A——D— | A—*C*DE | A—CDE |
| 21 .. | A—CDE | A—*C*D*E* | ABCDE | A—CDE | A—*C*DE | A—CDE | A—CDE | A—*C*DE | A—*C*DE | A—CDE | A—*C*DE | ABCDE |
| 22 .. | AB*C*DE | A—CDE | A—*C*DE | A—*C*DE | A—CDE | A—*C*D*E* | A———*E* | A——D— | A—*C*DE | A—*C*DE | A—*C*D*E* | ABCDE |
| 23 .. | ABCDE | ABCDE | A—*C*DE | A—CDE | A—CDE | A—CDE | A—*C*D— | A—CD*E* | ABCDE | A—*C*DE | A—*C*D— | ABCDE |
| 24 .. | ABCDE | ABCDE | ABCDE | A——D*E* | A—CDE | A—*C*DE | A——D— | A—CDE | ABCDE | A—CDE | A———— | ABCDE |
| 25 .. | ABCDE | ABCDE | AB*C*DE | A—CDE | A—CDE | A———*E* | A——D— | A——D*E* | A—CDE | A—*C*DE | AB*C*DE | ABCDE |
| 26 .. | A—*C*DE | ABCDE | ABCDE | AB*C*DE | A—CDE | A—CDE | — | A—*C*DE | A—C—E | A—CDE | A—*C*DE | ABCDE |
| 27 . | ABCDE | ABCDE | ABCDE | A—CDE | A—CD*E* | A—*C*DE | A——D*E* | A—CD*E* | A—CDE | A—*C*DE | A—*C*DE | ABCDE |
| 28 .. | A—*C*D*E* | ABCDE | AB*C*DE | A—*C*DE | A—*C*D*E* | ABCDE | A—CDE | A———— | A—*C*DE | AB*C*DE | ————— | A—*C*DE |
| 29 .. | A—CDE | | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | ————— | ABCDE | ABCDE | ————— |
| 30 .. | ABCD*E* | | A—CDE | A—CDE | A—CDE | A—CDE | A—*C*D*E* | A—*C*D*E* | A—*C*DE | ABCDE | ABCDE | A——D*E* |
| 31 .. | AB*C*DE | | A—*C*DE | | A—CDE | | A—CDE | A———— | | A—*C*DE | | A—CDE |

*Note.*—When a letter is in italics it means that on that day observations were not complete.

SOLAR Observations—Abstract.

| — | 1909. January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 28 | 28 | 31 | 30 | 28 | 29 | 29 | 30 | 28 | 30 | 29 | 29 | 349 |
| B | 18 | 13 | 10 | 6 | 7 | 5 | 1 | .. | 5 | 5 | 7 | 12 | 89 |
| C | 27 | 28 | 30 | 29 | 27 | 23 | 16 | 24 | 24 | 27 | 27 | 27 | 309 |
| D | 27 | 28 | 31 | 30 | 27 | 25 | 25 | 27 | 26 | 30 | 27 | 29 | 332 |
| E | 28 | 28 | 31 | 30 | 27 | 25 | 20 | 25 | 27 | 29 | 26 | 28 | 324 |

There was a general resemblance between the observing conditions in 1908 and 1909. July was the worst month in the year and the conditions were good in November. Sunspot observations were possible on five days more than in the previous year, but there was a slight fall in the number of days on which other solar observations and photographs were made.

6. **Photographs of the sun** with the Dallmeyer photoheliograph were taken on 332 days as against 338 in 1908. The greatest defect was in July when they were obtained on only 16 days At the request of Greenwich, double exposures are taken twice a month for determining the error of orientation of the photographs. Out of 91 solar negatives asked for by Greenwich Observatory it has been possible to supply 85.

7. **Observations of sunspots.**—The sun is examined for spots and faculae every morning when the weather permits. The sun's image is projected on an 8-inch disc and the positions of spots and faculae are marked on it. The discs are prepared by the cyanotype process from the large scale drawings of Father R. de Beaurepaire, as mentioned in last report.

8. **Sunspot spectra.**—(*a*) *Visual.*—This work is done in accordance with the suggestions issued by the committee of the International Union for Solar Research. It includes the comparison of the spot spectrum with a standard map for the region 5210 Å to F., a detailed study of C and $D_3$, and observations of variations in intensity of the following iron lines :—5383·58 5397·34, 5404·36, 5405·99, 5424·29, 5429·91, 5445·26, 5447·13, 4924·11, 5234·79, 5316·79 and 5535·06. Till April 30, 1909, the standard map mentioned above was the Mount Wilson provisional photographic map but since that date the map prepared in this Observatory in 1907 has been used.

(*b*) *Photographic.*— Spectrograph II. was employed early in the year in photographing spot spectra with high dispersion for the purpose of detecting relative displacements of the lines most and least affected by pressure. All the best plates of the series have been measured and the results published in the Observatory "Memoirs" (Part I.).

In the same series of photographs systematic line displacements due to radial movement of the penumbral gases were detected. The results of a preliminary investigation of this phenomenon have been published in bulletin No. 15, and in the *Monthly Notices* of the Royal Astronomical Society, Volume LXIX.

A new and very powerful spectrograph, No. III., has been constructed during the year. In this a parabolic silver-on-glass mirror forms the solar image on the slit plate, and a 6-inch plane grating by Michelson is used. Work with this instrument has been concentrated on problems connected with radial movement in sunspots, and a considerable proportion of the photographs secured with it have been measured.

The results indicate an accelerating outward movement of the gases at the base of the chromosphere in all spots, and an inward motion of calcium vapour at high levels in most spots. Particular attention was also given, in the case of large spots,

favourably situated on the disc to line displacements indicating a rotational movement, and strong evidence has been obtained in many instances of a relatively slow rotation, which is opposite in direction in the two hemispheres.

9. **General spectroscopic work.**—A series of limb and centre comparison plates of selected regions of the spectrum has been obtained with spectrograph III. These are on a scale of 1 mm. = 0·3Å and form excellent material for measurements of the displacements towards the red of the lines at the sun's limb. They will be studied with especial reference to (*a*) the lines most and least affected by pressure, and (*b*) the enhanced lines. They are also available for a study of the relative intensities of the lines at the sun's limb compared with the centre of the disc.

A spectrograph has been designed and partly constructed in the observatory workshop for photographing the spectrum of Halley's comet. It is intended to employ the 18-inch parabolic mirror for this work, and a reflecting slit made of silvered glass will be used.

10. **Prominences.**—Prominences were recorded visually on 309 days as against 310 in 1908, but on as many as 65 days the combined visual and photographic record was imperfect owing to unfavourable weather conditions. The weather was most unfavourable in July when the prominence record was complete on only 9 days. The record of the prominences is made round the disc on which spots and faculæ have been projected and with the discs now in use the apparent positions of prominences are easily read off directly. The visual record is compared with the spectroheliograms and all prominences shown in the photographs but not in the drawing as well as conspicuous extensions of Ca prominences inside the disc of the sun are added in blue pencil. Where there is much difference between the photograph and the drawing the differences are noted. In the case of eruptive or metallic prominences the spectra are examined, the most conspicuous bright lines are recorded, and all large displacements of the C line are also noted and their amounts estimated.

11. **Work with the spectroheliograph.**—This instrument was in use throughout the year. The camera slit of fixed width and fitted with windows at the two ends with automatic shutters has continued to work well. This slit, which was fitted in 1908, greatly simplifies the working of the instrument and the number of failures from imperfect adjustments has been negligible.

Photographs of the sun's disc in $K_2$ light were obtained on 324 days and limb photographs showing the prominences on 272 days. Most of the disc plates show the prominences also, more or less distinctly, even when the sky is too diffusive for limb photographs. It has been possible therefore to measure position angles and heights of prominences from all available plates on 312 days, the results for both prominences and flocculi were not statisfactory on 11 days owing to unfavourable weather.

The position angles and heights of the prominences photographed have been measured by Mrs. Evershed, who has also made detailed studies of the minute structure and changes of form in some of the more interesting cases.

The best disc plate of each day has been copied on an enlarged scale on bromide paper as heretofore, the prints so obtained being oriented and pasted in order on card sheets for future reference.

Prominence spectroheliograms for 39 days were received from the Solar Observatory, South Kensington, and flocculi plates for 321 days were sent in exchange.

12. **Solar radiation.**—Observations with the Ångström pyrheliometer were made on 5 days. The maximum reading obtained was 1·654 on January 11. The year as a whole has been very unfavourable for this work owing to the abundance of cirrus cloud.

The new method of estimating variations in the solar radiation mentioned in the last report has continued to occupy the attention of the Assistant Director, and a large amount of experimental work has been done.

The practicability of the method of comparing the photographic intensity of moonlight with that of the extra focal images of certain stars has been demonstrated and a form of apparatus which satisfies the required conditions has been worked out. Unfortunately the climate of Kodaikánal appears to be unsuited for this work as may be judged from the statement that throughout the past year there has been no single night near full moon in which the sky was entirely unclouded or free from faint streaks of cirrus. The tendency to heavy dews is also a serious difficulty. It is much to be desired that so promising a method of estimating changes in the sun's output of energy may be taken up at some more suitable locality.

*Summary of Results.*

13. **Sunspots.**—The following table shows the monthly number of new groups observed, the mean daily number of spots visible, and the distribution between the northern and southern hemispheres :—

| — | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups .. .. | 19 | 16 | 24 | 22 | 10 | 15 | 12 | 16 | 13 | 23 | 31 | 20 | 221 |
| Daily number .. .. | 4·5 | 4·2 | 4·4 | 3·1 | 2·7 | 2·2 | 2·2 | 2·3 | 2·4 | 4·5 | 4·9 | 4·8 | 3·5 |
| North .. .. .. | 8 | 5 | 6 | 4 | 3 | 4 | 7 | 6 | 6 | 13 | 13 | 8 | 83 |
| South .. .. .. | 11 | 11 | 18 | 18 | 7 | 11 | 5 | 10 | 7 | 10 | 18 | 12 | 138 |

There was a marked revival in spot activity during the last three months of the year but for the year as a whole there was a slight decrease. The total number of new groups for the years 1907, 1908, and 1909 were respectively 301, 262, and 220, and the mean daily numbers were 4·4, 4·6, and 3·9.

Southern spots continued to preponderate greatly over the northern, the proportion being even higher than in 1908. So also the mean latitude of southern spots was slightly higher than that of the northern ones in every month except September and November. The mean latitudes for the whole year were 8·9 for northern spots and 10·8 for the southern.

On five days the sun's surface was recorded as free from spots. There was one day, December 25, on which ten groups were observed. A striking feature of the last three months of the year was the comparatively large number of groups which contained fairly large spots.

The following were the most important groups of spots seen during the year :—

*January*—

Nos. 1593, 1594, 1595 — These spots were large and were changing rapidly. Their spectrum indicated that they were active. C was frequently observed reversed and dark $D_3$ was seen near them. In the case of No. 1593 the $D_3$ line was seen bright over the whole of the main umbra on the 23rd.

*February*—

Nos. 1605, 1607, 1609, 1611, 1612, 1613, 1615 — All of these were large and most of them were spectroscopically active. Reversals and displacements of C as well as darkening of $D_3$ were frequently observed near them.

*March*—

Nos. 1629, 1632 — These were scattered trains of spots and were very active as indicated by the behaviour of the C and $D_3$ lines.

*April*—

Nos. 1645
1649

were the only groups which contained fairly large spots. No. 1649 developed a large number of companions as it neared the central meridian, and by the time it had reached it, had become a train of three large spots.

*May*—

Nos. 1659
1662
1663
1667

All of these were large. No. 1663 was the only one in which disturbances in C and $D_3$ were frequently observed. It was first seen as a double-spot group with the two spots nearly equal in size, but the leader gradually diminished and the following spot increased in size till on the 15th the former had almost disappeared while the latter was a large spot but of irregular outline.

*June*—

Nos. 1671
1673
1678
1681
1683

All of these contained large spots. Nos. 1671, 1678 and 1681 first appeared on the sun as small spots and grew in size as they advanced westwards. Nos. 1673 and 1683 came round the east limb as large spots but the former dwindled away and disappeared before it reached the west limb.

*July*—

Nos. 1690
1693

were the only large spots. No. 1690, when traversing the eastern half of the sun, developed a large number of companions which began to vanish after it had crossed the central meridian. No. 1693 developed on the side of the sun turned towards us and was visible to the naked eye. The smaller companions of this spot also began to vanish when traversing the western half of the sun.

*August*—

No large spot appeared on the sun during the month.

*September*—

Nos. 1714
1715
1719
1725
1726

were the large spots of the month. Nos. 1725 and 1726 were returns of Nos. 1714 and 1715 respectively. The latter two after crossing the central meridian developed suddenly into trains of large spots. No. 1715, when it reached the west limb, was associated with a metallic and highly eruptive prominence. No. 1719 was a large spot when it came round the east limb on the 18th and for several days afterwards the C line was observed reversed on or near it. On the 28th at or a little before $10^h\ 30^m$ there was a sudden and very violent out-burst of bright gases on or near the spot. The whole area was seen as a bright prominence projected on the sun's disc though the observing conditions were poor. The prominence showed displacements of the hydrogen lines but the direction and the amount of motion indicated as well as the form of the prominence were rapidly changing. A Ca flocculus photograph taken at $10^h\ 39^m$ showed the spot region to be completely filled with bright matter and the spot itself was not visible. About the time of the outburst there was a sudden and large rise in the Horizontal Force record of the magnetograph.

*October*—

Nos. 1729
1734a
1731

These were the most important of the large spots seen during the month. Nos. 1729 and 1734a suddenly developed into trains of large spots when about 25° west of the central meridian. No. 1731 was a very large group covering nearly 15° of longitude. It was found to drift steadily westwards and its position in longitude had changed considerably before it returned as No. 1748. It underwent much change of form from day to day, C was frequently reversed in it, and $D_3$ was often seen dark. On October 15 when the group was within

2 days of the west limb C was brightly reversed over an extensive area near the group and it was seen as a changing prominence projected on the sun's disc. It was first observed at $9^h$ $13^m$ and there was nothing left of it by $10^h$ $30^m$.

*November*—

Nos. 1762, 1766, 1769, 1770, 1772 — All these contained large spots. No. 1766 formed near the central meridian and showed disturbances in C. No. 1772 also formed on the visible disc and after it had crossed the central meridian became a fine and active train of large spots.

*December*—

Nos. 1782, 1786, 1787, 1788, 1790, 1793, 1797 — All these lay between longitudes 57° and 253°. The other half of the sun was comparatively inactive. But even of these groups No. 1782 was the only one which showed any striking features, spectroscopically or otherwise.

14. **Prominences.**—The activity as estimated by profile areas has been well maintained throughout the year, but the numbers obtained show a reduction of 23 per cent. compared with the previous year.

The general activity of the two hemispheres compared with 1908 is given in the following table:—

*Mean daily profile areas of prominences.*

| | 1908. Square minutes. | 1909. Square minutes. |
|---|---|---|
| North .. .. .. .. .. | 2·41 | 2·10 |
| South .. .. .. .. .. | 2·98 | 2·04 |
| Total .. | 5·39 | 4·14 |

Considerable changes have taken place in the distribution of the prominences in latitude. The polar regions in both hemispheres have been inactive, that is, the mean areas in the regions comprised between latitudes 65° and the poles have fallen to less than one-tenth of the areas found in lower latitudes. A well-marked zone of activity has developed between the parallels 45° and 55° in the northern hemisphere, a corresponding active region in the south recorded in 1908 having subsided. Such alternations between north and south have been recorded previously and appear to be a characteristic feature of prominence development. This change has had the effect of restoring the balance of activity between the hemispheres which have been sensibly equal in 1909.

There has been a great reduction in the number of metallic prominences recorded, particularly in the southern hemisphere, and the mean latitudes have decreased largely. The mean and extreme latitudes observed are given in the following table:—

*Metallic prominences.*

| — | Number observed. | Mean latitude. | Extreme latitude. | |
|---|---|---|---|---|
| North .. .. .. | 21 | 8°·8 | 2° | 16° |
| South .. .. .. | 20 | 12°·2 | 2° | 22° |

The prominence activity in each month may be estimated from the following table :—

*Numbers of Prominences.*

| Month. | Prominences one minute or more in height. | Metallic. | Eruptive. |
|---|---|---|---|
| January .. .. .. .. | 57 | 5 | 4 |
| February .. .. .. .. | 64 | 7 | 8 |
| March .. .. .. .. | 52 | 6 | 6 |
| April .. .. .. .. | 73 | 6 | 6 |
| May .. .. .. .. | 43 | 1 | 1 * |
| June .. .. .. .. | 29 | 1 | 1 |
| July .. .. .. .. | 11 | 1 | .. |
| August .. .. .. .. | 24 | .. | . |
| September .. .. .. .. | 46 | 3 | 7 |
| October .. .. .. .. | 37 | 3 | 2 |
| November .. .. .. .. | 45 | 3 | 4 |
| December .. .. .. .. | 58 | 5 | .. |

* The eruptive prominence was also metallic.

The following were the more noteworthy prominences of the year :—

*January.*—The tallest and the most active prominence of the month was photographed on the 12th at $8^h\ 3^m$, the main part of it was an arch 15° in extent and 160″ high. Subsequent photographs showed it as changing both in form and height, and at $14^h\ 27^m$ there was nothing left except a narrow slanting strip 10° long, far away from the limb and about 285″ at the highest point.

*February.*—Two prominences photographed on the 25th reached a height of 240″.

*March.*—The tallest prominence for the month was photographed on the 7th and was 175″ high.

*April.*—The main part of an eruptive prominence recorded on the 21st was a bright, straight jet 220″ high in Ca, but in $H_\alpha$ it was only a faint detached streak about 90″ high. One of the prominences seen on the 23rd was associated with spot group 1651 and was bright and metallic, but its height though changing did not exceed 30″. C was displaced, and the direction as well as the amount of displacement frequently changed during the whole time of observation—from $9^h\ 45^m$ to $11^h\ 0^m$. The greatest displacement observed corresponded to a radial velocity of 115 miles a second towards the observer. The prominence showed about 30 bright lines between C and F.

*May.*—Two of the largest prominences of the month were detached clouds, 270″ and 240″ high, photographed near the west limb on May 16.

*June.*—An eruptive prominence was recorded on the 23rd, situated at latitude + 25° west, at $8^h\ 50^m$. C was displaced to violet over the whole prominence, the maximum displacements being 4 Å. The prominence was changing rapidly. The height in Ca varied from 70″ at $8^h\ 7^m$ to 230″ at $9^h\ 21^m$ and 150″ at $9^h\ 50^m$. A rather faint prominence, 90″ high, was photographed at this position on the next day.

*July.*—Only one metallic prominence was observed during the month. It was seen on July 6 at latitude — 8° east.

*August.*—The highest prominence recorded was only 120″. The only prominence which showed any activity was a very bright one, 45″ high, seen at latitude + 9° east at $10^h\ 10^m$ on the 14th. At $10^h\ 20^m$ there was only a detached streak 20″ high left of it. An hour previously at about $9^h\ 6^m$ nothing had been seen at the same place. The Ca photographs also did not show anything.

*September.*—The tallest prominence recorded for the month was also an eruptive one which was photographed at latitude — 15° west on the 23rd, and reached a height of 330″.

*October.*—The tallest prominence of the month was 240″ high observed in about the same position on the 9th and 10th.

*November.*—A highly eruptive prominence which was also the highest for the month was recorded at latitude + 13° east on the 30th. C was displaced and the amount and direction of the displacement, as well as the form of the prominence, underwent rapid changes. The maximum displacement corresponded to a velocity towards the observer of 200 miles a second and the maximum height recorded was 360″. A smaller, but equally active and brighter prominence, had been observed at the same position on the previous day. A noteworthy feature was that, during one of the transformations it was undergoing, the main part consisted of a number of bright concentric arches.

*December.*—The tallest prominence of the month was a detached vertical strip 360″ high which was photographed at latitude — 55° east at $8^h$ $13^m$ on December 23.

(*b*) OTHER OBSERVATIONS.

15. **Time.**—The error of the standard clock is usually determined by reference to the $16^h$ signal sent from the Madras Observatory. This is rendered possible by the courtesy of the Telegraph department which permits the Madras wire to be joined through to this observatory. The signal is received with accuracy on most days and all failures are at once reported to the officer in charge of the Madura division who takes much interest in the accuracy of the time service. Time determinations are made with the transit instrument at frequent intervals, as a check.

The usual time signal to the station was given, by means of a flag, throughout the year.

16. **Meteorology.**—Meteorological observations were carried on as in former years. Eye observations are made at $8^h$, $10^h$, and $16^h$ local mean time. Temperatures and pressures are recorded continuously by a Richard's thermograph (wet and dry bulb) and barograph, and the mean temperature and pressure are obtained from the traces corrected by reference to the eye observations. The wind direction and velocity are obtained from a Beckley anemograph.

*Pressure.**—The mean pressure for the year was 0·029 inch below the normal. It was in defect in every month of the year. The highest mean pressure recorded was 22·919 inches on March 27 and the lowest 22·611 on June 3.

*Temperature.*—The mean temperature for the year was 0°·3 below normal. It was 1°·4 in excess in January normal in March and in defect in all other months. The greatest defect was 0·8 in July. The maximum shade temperature recorded was 72°·7 on March 9, and the minimum 43°·0 on February 6. The highest temperature shown by the black bulb *in vacuo* was 142°·6 on April 17 and the lowest temperature on the grass was 26°·2 on February 13.

*Humidity.*—The mean humidity of the year was normal. The greatest differences from normal were a defect of 15 °/o in January and an excess of 6 °/o in August, November, and December.

*Rain.*—The total rainfall for the year was considerably above normal and the distribution throughout the year was very abnormal. It was largely in excess in January and August (7 inches and 10 inches), and largely in defect in September and December ($5\frac{1}{2}$ and 4 inches). The rainfall of August was a record for that month while that of September was the smallest on record. The greatest fall in one day was 4·51 inches on January 1.

*Wind.*—On the average for the year the wind was somewhat weaker and two points more northerly than the average. The amount was in considerable excess in January, March, and September and in considerable defect in April, June, October, and December. The largest amount of wind in any one day was 689 miles on March 5 and the smallest 104 miles on May 28.

* There is some reason to believe that these barometer readings are about 0·01 inch too low, but no change in the barometer correction can be made till a comparison is obtained with a standard.

*Transparency of the atmosphere.*—The transparency of the lower atmosphere, as judged by the visibility of the Nilgiris, was much below the average. They were seen on only 147 days as against 175 in 1908.

*Cloud and sunshine.*—The year as a whole was rather less cloudy than usual and the amount of bright sunshine exceeded the average by 140 hours.

17. **Seismology.**—The Milne horizontal pendulum worked well throughout the year and the results are given in Appendix I. The watch had to be sent to Madras for repairs in November, but this did not affect the working of the instrument as the standard clock marks each hour on the paper by an electrical device, and the marks made by the watch are used only in case of a failure in the electric record. Sixty-eight earthquakes were recorded during the year. The original records are retained here, but copies of the traces of the more important shocks are sent to the British Association Committee, the Strassburg International Bureau, and to other workers on the subject who ask for them.

18. **Library.**—One hundred and fifty-eight books were bound during the year.

19. **Publications.**—Bulletins Nos. XIV. to XVIII. were published during the year, No. XIX. is in the press and Part I. Volume I. of the Memoirs was ready for distribution at the end of the year. Bulletins Nos. XIV. and XVII. deal with prominences observed in 1908, No. XV. with "Radial movement in spots" and No. XVIII. with "Pressure in the reversing layer"; No. XVI. is "On the curvature of lines in the spectrum formed by a plane grating," by Dr. Gilbert T. Walker. In addition to these, the following papers were published during the year:—

"Radial Movement in Sunspots" by J. Evershed. (M.N., R.A.S., LXIX., No. 5.)

"A Solar Outburst and a Magnetic Storm" by C. Michie Smith. (M.N., R.A.S., LXX., No. 1.)

20. **General**—.Sufficient observations having been obtained for comparative purposes, the Periyakulam Observatory was closed at the end of April 1909.

The Director-General of Observatories visited the Kodaikánal and Madras Observatories in January. The Director visited the Madras Observatory in November. When there, he obtained an interview with His Excellency the Governor to discuss the probable effect on the Madras Observatory of the proposed erection of a new General Hospital on the Spur Tank (see the Deputy Director's report). His Excellency promised that, if the scheme was carried out, all necessary care would be taken to safeguard the interests of the Observatory.

The Public Works Department has so far made no progress with the electric light installation in spite of various attempts made by the Director to impress upon it the urgency of the work.

The staff of the Observatory has worked well throughout the year and the First Assistant, Mr. S. Sitarama Aiyar, deserves special mention for efficiency and zeal.

THE OBSERVATORY, KODAIKÁNAL,
*February* 1910.

C. MICHIE SMITH,
*Director, Kodaikánal and Madras Observatories.*

## II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1909.

1. **Staff.**—The computer went on privilege leave for one month. There were no other changes in the staff during the year.

2. **Time Service.**—No change was made in the programme of astronomical observations; these have been restricted as usual to meridian observations to determine time. The only change in the time signals distributed is the following; the 4 P.M. roll now commences 2 minutes before 4 P.M., instead of 3 minutes as hitherto. The change has been in effect since the 19th of March under the order of the Director of the Observatory. The Fort Time Signal was fired correctly at noon and 8 P.M., on 701 out of 730 occasions giving a percentage of success of 96. Some of these failures were traced to the bad earth at the Observatory; a new one was therefore put down in the bed of the river by the Telegraph Department. The time ball at the Port Office was dropped correctly at 1 P.M. on every occasion except 4 throughout the year and on 2 out of these 4 it was dropped correctly at 2 P.M.

3. **Meteorological Observations.**—Meteorological observations were continued as usual. The $10^h$ and $16^h$ observations were reduced and sent to the India Meteorological office on Form F. Observations on cloud movement were continued. Besides the ordinary weather telegrams, special storm observations were sent on two occasions to Simla and on 47 occasions to Calcutta. The tabulation of the traces of the autographic instruments at Madras and of the anemograph at Dodabetta are brought up to date.

4. **Buildings.**—Certain repairs to the quarters of the Deputy Director were effected during the year.

5. **Instruments.**—The following is the list of instruments at the Madras Observatory on the 31st December 1909 :—

(*a*) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton & Simms.
Sidereal Clock—Haswall.
,, Dent, No. 1408.
,, S. Reifler, No. 61.
Mean Time Clock with galvanometer—Shepherd & Sons.
Meridian Circle—Troughton and Simms.
Mean Time Clock—J. Monk.
Mean Time Chronometer—V. Kullberg, No. 5394.
,, ,, No. 6544.
,, Parkinson and Frodsham, No. 2352.
Portable Transit Instrument—Dolland.
Portable Telescope with stand.
Tape Chronograph—R. Fuess.
Relay for use with the Chronograph—Siemens.

(*b*) *Meteorological.*

Richard's Barograph—No. 10, L. Casella.
,, Thermograph—No. 3618, L. Casella.
Beckley's Anemograph—Adie.
Sunshine Recorder—No. 149, L. Casella.
Anemoscope—P. Orr & Sons.
Nephoscope—Mons Jules Daboscq & Ph. Pellin.
Barometer, Fortin's—No. 1771, L. Casella.
,, No. 725, L. Casella (spare).
,, No. 1420, L. Casella (spare).
Dry Bulb Thermometer—No. 94221, L. Casella.
,, No. 38037, Negretti & Zambra (spare).
Wet Bulb Thermometer—No. 94219, L. Casella.
,, No. 38037, Negretti & Zambra (spare).
Dry Maximum Thermometer—No. 8581, Negretti & Zambra.
Dry Minimum Thermometer—No. 69047, L. Casella.
Wet Minimum Thermometer—No. 91753, Negretti & Zambra.
Sun Maximum Thermometer—No. 10479, Negretti & Zambra.
Grass Minimum Thermometer—No. 3377, Negretti & Zambra.
Rain-gauge (8″ diameter)—No. 1042, Negretti & Zambra.

Measure glass for above.
Rain-gauge (5″ diameter).
Measure glass for above.

The axes and bearings of the transit instrument were examined and cleaned during the visit of the Director in November. The rate of the Riefler Clock has been steady. The Haswall Clock which was taken down last year was put up again and is keeping a steady rate. The Sidereal Clock by Dent was cleaned and the cord carrying the weight was renewed.

The body of the equatorial and the pillar were painted, the clock work, circles and the eye-pieces were cleaned by Messrs. P. Orr & Sons in the early part of the year. Halley's comet was first observed on the 3rd of December.

In the latter half of September it was stated that a proposal was under consideration to build a new General Hospital in the Spur Tank—a site on the meridian through our transit and a little over one-fourth mile to the north of it. As I considered that this proposal, if carried into effect, would prejudicially affect our observations of close polar stars and might even render them valueless or impossible, it was my duty to call the attention of the Director of the Observatory and the Director-General to the matter. This was done, and representations have been made on the matter.

6. **Weather summary.**—The following is a summary of the meteorological conditions at Madras during the year 1909 :—

*Pressure.*—Pressure was below normal in all months except July and August. The greatest excess was 0·010 inch in August and the greatest defect 0·043 inch in January. The highest pressure was 30·104 inches on December 29, and the lowest 29·476 inches on June 5.

*Temperature.*—The mean temperature was above the average in January, February, June, October, November, and December and below normal during the other months. The maximum temperature was below normal in all months except October, November, and December, the greatest excess being 4°·3 in October and the greatest defect 2°·8 in September. The minimum was above normal in January, February, November, and December, normal in October and below normal during the rest of the year. The minimum on the grass was above normal in all months except May, July and October. The highest shade temperature recorded was 106°·1 on May 30 and the lowest 64°·5 on January 25.

*Humidity.*—The percentage of humidity was normal in October and December, below normal in November, and above normal during the remaining months. The driest day was July 18 with 34 per cent. of humidity.

*Wind.*—Wind direction was normal for February and May; it differed most from normal in September when it was 3 points more westerly than usual, the average direction being south-west. The recorded air movement was apparently lower than usual throughout the year. This however is an effect due to a gradual change in exposure of the anemometer. The movement was certainly lighter than usual in May when hot weather conditions were much less intense than they often are in this month. The abnormal and heavy rain in April and May had completely changed the character of the surface of the country, and persistent high temperatures with vigorous air movement attending were impossible.

*Cloud.*—The percentage of cloud was above normal in February and below normal during the remaining months

*Sunshine.*—The percentage of bright sunshine was above normal in October and December and below normal during the rest of the year. The total number of hours of bright sunshine during the year was 2,271·1 hours.

*Rainfall.*—The rainfall was above the average in January, April, May, July, August and September and below during the other months, the greatest excess being 9·69 inches in April and the greatest defect 10·39 inches in October. The rainfall for the year was 46·53 inches on 86 days, being 2·49 inches below the normal. The

monsoon rainfall from 15th October to the end of the year was only 4·85 inches against an average of 26·00 inches. Several storms formed in the Bay during the period, but they formed far to the east and travelled in northerly directions taking the monsoon with them and away from the Madras Coast. The greatest fall on any day was 5·42 inches on May 4.

*Storms.*—A storm formed in the south-west of the Bay on May 2 and moving on a westerly course crossed the Madras Coast on May 4. It was of no great severity but was effective in directing the south-westerly winds that were blowing into the Bay at this time, towards the Madras Coast; hence heavy and general rain fell at Madras and all over the south. The depression passed out into the Arabian Sea where it depeened again, and gave very heavy rain on the West Coast.

MADRAS OBSERVATORY,
29*th January* 1910.

R. LL. JONES,
*Deputy Director*.

# Appendix I.

Kodaikánal Observatory Seismological Records in 1909.

| No. | Date. | P.T. commence G.M.T. H. | M. | L.W. commence G.M.T. H. | M. | Maxima G.M.T. H. | M. | End. H. | M. | Max. Amp. MM. = " | Duration H. | M. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1909. | | | | | | | | | | | | |
| 1 | Jan. 22 | 12 | 38·2 | 12 | 43·3 | 12 | 46·9 | 13 | 08 | 1·1 = 0·5 | 0 | 30 | |
| 2 | 23 | 2 | 56·7 | 3 | 11·5 | 3 | 14·6 | 4 | 41 | 2·0 = 0·9 | 1 | 44 | Luristan, Persia. |
| 3 | 29 | 1 | 18·8 | .. | | .. | | 2 | 03 | .. | 0 | 44 | Widening of line. |
| 4 | Feb. 2 | 19 | 12·2 | 19 | 18·8 | 19 | 21·9 | 19 | 43 | 0·6 = 0·3 | 0 | 31 | |
| 5 | 9 | 11 | 37·2? | 11 | 55·3 | 11 | 56·9 | 12 | 47 | 1·0 = 0·5 | 1 | 10 | |
| 6 | 9 | 14 | 38·0 | .. | | .. | | 15 | 53 | .. | 1 | 15 | Widening of line. |
| 7 | 22 | 9 | 41·3 | 9 | 45·4 | 9 | 45·4 | 10 | 59 | 0·5 = 0·2 | 1 | 18 | |
| 8 | Mar. 7 | 18 | 47·4 | .. | | .. | | 19 | 06 | .. | 0 | 19 | Widening of line. |
| 9 | 12–13 | 23 | 37·1 | 0 | 02·5 | 0 | 06·1 | 0 | 51 | 1·0 = 0·5 | 1 | 14 | |
| 10 | 13 | 14 | 39·8 | 15 | 11·4 | 15 | 12·3 | 15 | 55 | 0·6 = 0·3 | 1 | 15 | |
| | | | | | | | 13·6 | | | 0·6 = 0·3 | | | |
| 11 | 17 | 10 | 33·1 | 10 | 38·2 | 10 | 39·2 | 10 | 47 | 0·3 = 0·1 | 0 | 14 | |
| 12 | 17–18 | 23 | 01·3 | 23 | 15·3 | 23 | 23·9 | 0 | 12 | 3·5 = 1·7 | 1 | 10 | |
| 13 | 23 | 20 | 41·2 | 20 | 47·4 | 20 | 48·9 | 21 | 08 | 0·6 = 0·3 | 0 | 27 | |
| 14 | Apl. 10 | 5 | 51·5 | 6 | 44·3 | 6 | 47·4 | 7 | 59 | 0·7 = 0·3 | 2 | 07 | |
| 15 | 10 | 18 | 58·4 | 19 | 29·0 | 19 | 34·1 | ? | | 1·1 = 0·5 | ? | | These run into each other. |
| 16 | 10 | 20 | 07·2? | 20 | 25·9 | 20 | 29·0 | 21 | 38 | 2·0 = 1·0 | 1 | 31 | |
| 17 | 11 | 14 | 45·4 | 14 | 51·5 | 14 | 53·6 | 15 | 22 | 0·5 = 0·2 | 0 | 37 | |
| 18 | 14 | 2 | 51·7 | 2 | 54·3 | 2 | 54·8 | 3 | 16 | 0·9 = 0·4 | 0 | 24 | Felt at Simla. |
| 19 | 14 | 20 | 01·8 | 20 | 22·3 | 20 | 25·2 | 20 | 48 | 0·5 = 0·2 | 0 | 46 | |
| 20 | 25 | 22 | 08·4 | .. | | .. | | 23 | 29 | .. | 1 | 21 | Widening of line. |
| 21 | 27 | 12 | 55·6 | 13 | 36·2 | 13 | 38·2 | 14 | 42 | 0·9 = 0·4 | 1 | 46 | |
| 22 | 29 | 22 | 57·6 | 23 | 03·7 | 23 | 04·8 | 24 | 08 | 1·1 = 0·5 | 1 | 10 | |
| 23 | May 2 | 7 | 49·7 | .. | | .. | | 8 | 24 | .. | 0 | 34 | Widening of line. |
| 24 | 2 | 22 | 12·7 | 22 | 13·3 | 22 | 14·3 | 22 | 42 | 0·6 = 0·3 | 0 | 29 | |
| 25 | 3 | 0 | 11·2 | 0 | 12·2 | 0 | 13·3 | 0 | 22 | 0·8 = 0·4 | 0 | 11 | |
| 26 | 10 | 20 | 24·9 | 20 | 24·9 | 20 | 27·4 | 20 | 57 | 2·3 = 1·1 | 0 | 32 | |
| 27 | 12 | 1 | 35·6 | 1 | 40·7 | 1 | 47·4 | 2 | 21 | 0·5 = 0·2 | 0 | 45 | |
| 28 | 17 | 8 | 22·3 | 8 | 35·1 | 8 | 41·3 | 10 | 22 | 0·6 = 0·3 | 2 | 00 | |
| 29 | 30 | 21 | 10·5 | 21 | 30·0 | 21 | 36·1 | 22 | 27 | 0·6 = 0·3 | 1 | 17 | |
| 30 | June 3 | | ? | 18 | 42·3 | Boom struck stops. | | 23 | 01? | 18+ = +8·6 | ? | | Boom reached stops 18ʰ 56·7ᵐ to 19ʰ 0·8ᵐ Gale of wind. |
| 31 | 8 | 6 | 06·2 | 7 | 07·2 | 7 | 19·7 | 8 | 23 | 1·1 = 0·5 | 2 | 17 | |
| 32 | 12 | 20 | 44·4 | 21 | 00·3 | 21 | 20·3 | 22 | 13 | 1·0 = 0·5 | 1 | 29 | |
| 33 | 18 | 7 | 46·4 | .. | | .. | | 8 | 03 | .. | 0 | 17 | Widening of line. |
| 34 | 27 | 7 | 39·2? | 8 | 13·1 | 8 | 25·4 | 9 | 24 | 0·6 = 0·3 | 1 | 45 | |
| 35 | July 7 | 21 | 43·3 | 21 | 48·0 | 21 | 51·0 | .. | | 12 = 5·8 | .. | | |
| | | | | | | | 53·6 | 23 | 37 | 14 = 6·7 | 1 | 54 | |
| 36 | 26 | 10 | 39·2 ? | 11 | 03·3 | 11 | 04·4 | 11 | 45 | 1·6 = 0·7 | 1 | 06 | |
| 37 | 30 | 11 | 07·6 | 12 | 21·9 | 12 | 40·2 | 13 | 55 | 1·5 = 0·7 | 2 | 47 | Mexico city. |
| 38 | 31 | 20 | 43·7 | 21 | 04·1 | 21 | 05·7 | 21 | 44 | 0·5 = 0·2 | 1 | 00 | |
| 39 | Aug. 1 | 10 | 31·0 | .. | | .. | | 10 | 55 | .. | 0 | 24 | Widening of line. |
| 40 | 4 | 7 | 58·7 | .. | | .. | | 8 | 10 | .. | 0 | 11 | Widening of line. |
| 41 | 14 | 6 | 44·6 | 7 | 13·1 | 7 | 14·1 | 8 | 05 | 1·1 = 0·5 | 1 | 20 | Japan. |
| 42 | 16 | 8 | 18·5 | 8 | 29·5 | 8 | 31·0 | 9 | 13 | 0·5 = 0·2 | 0 | 55 | |
| 43 | 22 | | ? | 6 | 33·1 | 6 | 34·6 | 6 | 54 | 0·6 = 0·3 | ? | | |
| 44 | 22 | 15 | 48·5 | .. | | 15 | 54·1 | 16 | 16 | .. | 0 | 28 | Widening of line. |
| 45 | Sept. 3 | 11 | 33·0 | .. | | .. | | 11 | 41 | .. | 0 | 08 | Widening of line. |
| 46 | 5 | 9 | 20·6 ? | 9 | 26·4 | 10 | 00·0 ? | 9 | 58 | 1·1 = 0·5 | 0 | 17 | |
| 47 | 6 | 8 | 36·1 ? | .. | | 8 | 42·3 | 8 | 58 | .. | 0 | 22 | Widening of line. |
| 47A | 7 | 15 | 36·2 | 15 | 43·3 | 15 | 44·0 | 16 | 07 | 0·4 = 0·2 | 0 | 31 | |
| 48 | 8 | 17 | 02·3 | 17 | 15·4 | .. | | 17 | 46 | .. | 0 | 44 | Widening of line. |
| 49 | 8 | 19 | 56·7 | .. | | .. | | 20 | 20 | .. | 0 | 23 | Widening of line. |
| 50 | 11 | 5 | 18·7 | .. | | .. | | 5 | 42 | .. | 0 | 23 | Widening of line. |
| 51 | 11 | 11 | 09·0 | 11 | 22·7 | .. | | 12 | 16 | .. | 1 | 07 | Widening of line. |
| 52 | 16 | 19 | 00·2 | 19 | 08·0 | 19 | 10·0 | 19 | 28 | 0·5 = 0·2 | 0 | 28 | |
| 53 | 16 | 19 | 57·7 | 20 | 23·8 | 20 | 24·4 | 20 | 39 | 0·4 = 0·2 | 0 | 41 | |
| 54 | 21 | 19 | 09·0 | .. | | .. | | 19 | 51 | .. | 0 | 42 | Widening of line. |
| 55 | 23 | 6 | 31·0 | 6 | 35·1 | 6 | 36·2 | 6 | 57 | 0·6 = 0·3 | 0 | 26 | |
| 56 | 27 | 6 | 02·7 | .. | | .. | | 6 | 18 | .. | 0 | 15 | Widening of line. |
| 57 | Oct. 17 | 22 | 34·1 | .. | | .. | | 22 | 43 | .. | 0 | 09 | Widening of line. |
| 58 | 20–21 | 23 | 44·9 | 23 | 50·6 | 23 | 52·7 | 1 | 21 | 15+ = 7+ | 1 | 36 | Quetta. |
| 59 | 23 | 10 | 05·4 ? | 10 | 08·0 | ? | | 10 | 13 | .. | 0 | 08 | Widening of line. |
| 60 | 30 | 10 | 22·5 | 10 | 37·7 ? | 10 | 39·3 | 11 | 27 | 0·6 = 0·3 | 1 | 05 | |
| 61 | 31 | 11 | 06·9 | 11 | 58·7 ? | 12 | 14·1 | 12 | 37 | 0·5 = 0·2 | 1 | 30 | |
| 62 | Nov. 10 | *6 | 22·3 | 6 | 30·2 | 6 | 31·0 | 7 | 56 | 1·6 = 0·7 | 1 | 34 | * Possibly 2nd P.Ts. |
| 63 | 21 | 7 | 49·7 | 8 | 03·6 | 8 | 06·2 | 8 | 53 | 1·1 = 0·5 | 1 | 03 | |
| 64 | Dec. 9 | 15 | 46·9 ? | 15 | 42·8 | 16 | 45·4 | 17 | 46 | 0·7 = 0·3 | 1 | 59 | 2nd P. Ts. 15ʰ 57·7ᵐ |
| 65 | 9 | 21 | 48·5 | 22 | 18·7 | 22 | 24·4 | 23 | 21 | 1·0 = 0·5 | 1 | 33 | Possibly these two run into each other. |
| 66 | 9–10 | 23 | 39·2 | 23 | 48·1 | 23 | 52·8 | 1 | 24 | 1·1 = 0·5 | 1 | 45 | |
| 67 | 29 | 19 | 35·1 | .. | | .. | | 19 | 59 | .. | 0 | 24 | Widening of line. |

# Appendix II.

Latitude—10° 13′ 50″ N.
Longitude—5h 09m 52s E.

Height of barometer cistern above mean sea level, 7,688 feet.

## MEAN monthly and annual Meteorological Results at the Kodaikánal Observatory in 1909.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer. Mean. | Dry bulb thermometer. Max. | Dry bulb thermometer. Min. | Dry bulb thermometer. Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. By Blanford's tables. | Relative humidity. By Blanford's tables. | Sun Max. *in vac.* | Min. on grass. | Wind. Daily velocity. | Wind. Mean direction. | Wind. Mean direction. | Rain. Amount. | Rain. Days. | Clear sky. | Hours of Bright sunshine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | POINTS. | POINTS. | INCHES. | NO. | CENTS. | |
| January .. .. | 22·806 | 0·068 | 54·5 | 63·1 | 48·7 | 14·4 | 45·3 | 40·1 | 0·217 | 51 | 112·1 | 39·5 | 385 | 5 | N. E. by E. | 9·87 | 5 | 66 | 251 2 |
| February .. | ·822 | ·066 | 54·4 | 65·5 | 47·1 | 18·4 | 46·7 | 40·0 | ·244 | 58 | 120·6 | 37·0 | 306 | 32 | N. | 0·08 | .. | 69 | 251·8 |
| March .. .. | ·830 | ·065 | 57·9 | 68·8 | 51·2 | 17·6 | 48·2 | 41·6 | ·246 | 51 | 127·9 | 41·8 | 363 | 4 | N. E. | 1·84 | 7 | 63 | 255·6 |
| April . .. | ·806 | ·072 | 58·9 | 67·6 | 53·3 | 14·3 | 54·3 | 49·0 | ·380 | 75 | 130·2 | 44·6 | 242 | 3 | N. E. by N. | 3·60 | 8 | 54 | 223·1 |
| May .. .. | ·776 | ·070 | 59·4 | 66·7 | 54·7 | 12·0 | 55 2 | 50·9 | ·397 | 78 | 123·3 | 47·8 | 268 | 31 | N. by W. | 8·17 | 14 | 42 | 189·3 |
| June .. .. | ·738 | ·060 | 57·2 | 64·4 | 53·0 | 11·4 | 53·2 | 48·4 | ·366 | 78 | 121·9 | 46·8 | 340 | 27 | N. W. by W. | 3·63 | 10 | 26 | 143·7 |
| July .. .. | ·745 | ·055 | 55·6 | 62·0 | 52·1 | 9·9 | 52·7 | 49·5 | ·371 | 84 | 113·2 | 48·8 | 443 | 26 | W. N. W. | 3·49 | 8 | 19 | 101·9 |
| August .. .. | ·760 | 071 | 56·3 | 62·0 | 52·8 | 9·2 | 54·5 | 50·9 | 403 | 89 | 115·7 | 48·3 | 260 | 26 | W. N. W. | 16·01 | 22 | 22 | 106·0 |
| September .. | ·759 | ·068 | 56·0 | 62·7 | 51·7 | 11·0 | 53·0 | 48·1 | ·374 | 83 | 119·7 | 47·0 | 344 | 28 | N. W. | 2·23 | 7 | 32 | 145·8 |
| October .. | ·794 | ·076 | 55·3 | 61 9 | 51·3 | 10·6 | 53·1 | 49·3 | ·385 | 88 | 116·5 | 46·3 | 205 | 3 | N. E. by N. | 11·23 | 16 | 30 | 130·5 |
| November .. | ·818 | ·071 | 53·5 | 59·9 | 49 5 | 10·4 | 51·6 | 47 7 | ·365 | 89 | 110·6 | 44·5 | 241 | 30 | N. N. W. | 3·77 | 9 | 31 | 149·9 |
| December .. | ·821 | ·070 | 52·8 | 61·3 | 46·9 | 14·4 | 48·7 | 42·4 | ·305 | 76 | 110·2 | 38·2 | 253 | 4 | N. E. | 1·32 | 4 | 48 | 184·3 |
| Annual .. | 22·790 | 0·068 | 56·0 | 63·8 | 51·0 | 12·8 | 51·4 | 46·5 | 0·338 | 75 | 116·8 | 44·2 | 304 | 0 | N. | 68·24 | 110 | 42 | 2,133·1 |

## EXTREME monthly Meteorological Records at the Kodaikánal Observatory in 1909.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry bulb Thermometer. Highest. | | Dry bulb Thermometer. Lowest. | | Wet bulb. Lowest. | | Humidity. Lowest. | | Sun Th. *in vacuo.* Highest. | | Grass therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES | DAY. | INCHES. | DAY. |
| January . .. | 22·887 | 24 | 22·626 | 1 | 0·261 | 68·8 | 25 | 44·6 | 30 | 32·1 | 11,12 | 7 | 13 | 122·2 | 18 | 28·2 | 13 | 552 | 3 | 172 | 5 | 4·51 | 1 |
| February .. | ·902 | 11 | ·756 | 1 | ·146 | 70·7 | 25 | 43·0 | 6 | 34·0 | 6 | 11 | 13 | 129·5 | 19 | 26·2 | 13 | 415 | 18,24 | 157 | 14 | 0·08 | 20 |
| March .. .. | ·919 | 27 | ·762 | 8 | ·157 | 72 7 | 9 | 48·9 | 26 | 34·9 | 17 | 6 | 17 | 139·7 | 7 | 34·2 | 12 | 689 | 5 | 184 | 19 | 1·81 | 26 |
| April .. .. | 886 | 15 | ·723 | 20 | ·163 | 71·2 | 17 | 50·4 | 23 | 45·0 | 2,29 | 40 | 2 | 142·6 | 17 | 39·3 | 12 | 483 | 29 | 112 | 18 | 0·97 | 28 |
| May . .. | ·880 | 23 | ·624 | 6 | 256 | 71·2 | 2 | 49·5 | 4 | 40·8 | 10 | 32 | 10 | 140·5 | 13 | 37·2 | 10 | 622 | 4 | 104 | 28 | 1·37 | 5 |
| June .. .. | ·864 | 17 | 611 | 3 | ·253 | 70·2 | 19 | 50·8 | 27 | 42·1 | 17,29 | 38 | 17 | 138·8 | 19 | 38·1 | 16 | 575 | 8 | 138 | 29 | 0·56 | 3 |
| July . .. | ·857 | 22 | ·666 | 12 | ·191 | 66·6 | 19 | 48·9 | 18 | 45·7 | 3 | 62 | 3 | 134·1 | 20 | 40·0 | 21 | 583 | 6 | 118 | 21 | 1·33 | 1 |
| August .. .. | ·853 | 10 | ·652 | 21 | ·201 | 65·5 | 6 | 50·7 | 1 | 47·4 | 1,10 | 68 | 22 | 138·4 | 6 | 42·3 | 17 | 484 | 1 | 150 | 7 | 2·76 | 27 |
| September .. | ·863 | 28 | ·650 | 4 | ·213 | 67·2 | 24 | 48·7 | 20 | 41·2 | 18 | 52 | 7 | 136·6 | 28 | 41 1 | 21 | 601 | 3 | 143 | 27 | 0·54 | 27 |
| October . .. | ·877 | 22 | ·699 | 9 | ·178 | 66·7 | 2 | 45 9 | 28 | 40·2 | 28 | 43 | 28 | 132·5 | 2 | 34 8 | 29 | 464 | 27 | 110 | 5 | 1·78 | 5 |
| November .. | 904 | 10 | ·725 | 20 | ·179 | 64·7 | 25 | 46·0 | 12 | 40·4 | 15 | 56 | 15 | 127·2 | 25 | 35·5 | 15 | 417 | 30 | 107 | 24 | 1·01 | 28 |
| December .. | ·898 | 22 | ·698 | 4 | ·200 | 66 0 | 24 | 43·4 | 28 | 36·1 | 22 | 11 | 15 | 130·8 | 6 | 29·0 | 5 | 437 | 17 | 116 | 11 | 0 51 | 8 |

# Appendix III.

KODAIKÁNAL mean hourly wind velocity for the year 1909.

| Month. | Hours. | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| January .. | 17 | 16 | 16 | 17 | 18 | 17 | 18 | 18 | 19 | 19 | 18 | 19 | 18 | 17 | 15 | 14 | 12 | 11 | 13 | 13 | 14 | 15 | 15 | 15 |
| February . | 14 | 14 | 14 | 15 | 14 | 14 | 15 | 15 | 17 | 17 | 18 | 16 | 14 | 12 | 12 | 10 | 9 | 8 | 9 | 9 | 9 | 10 | 12 | 12 |
| March . | 17 | 16 | 16 | 17 | 17 | 16 | 17 | 18 | 18 | 18 | 19 | 18 | 15 | 14 | 13 | 12 | 10 | 9 | 9 | 11 | 13 | 15 | 16 | 17 |
| April .. | 10 | 10 | 9 | 9 | 10 | 10 | 10 | 10 | 11 | 11 | 13 | 12 | 11 | 12 | 12 | 11 | 9 | 9 | 8 | 8 | 8 | 10 | 10 | 11 |
| May .. | 11 | 11 | 11 | 11 | 11 | 11 | 10 | 10 | 12 | 12 | 12 | 11 | 12 | 12 | 12 | 12 | 11 | 10 | 10 | 10 | 10 | 11 | 11 | 11 |
| June .. | 15 | 15 | 16 | 16 | 16 | 16 | 14 | 12 | 13 | 12 | 12 | 14 | 13 | 13 | 14 | 14 | 14 | 13 | 13 | 14 | 15 | 15 | 15 | 16 |
| July .. | 21 | 22 | 20 | 19 | 19 | 19 | 18 | 17 | 17 | 15 | 18 | 17 | 17 | 15 | 16 | 16 | 17 | 19 | 20 | 20 | 20 | 20 | 18 | 20 |
| August .. | 12 | 12 | 11 | 12 | 12 | 11 | 12 | 12 | 11 | 11 | 12 | 11 | 10 | 10 | 10 | 11 | 11 | 10 | 11 | 9 | 9 | 10 | 11 | 12 |
| September .. | 17 | 16 | 17 | 17 | 17 | 17 | 17 | 16 | 16 | 15 | 15 | 14 | 13 | 13 | 12 | 12 | 11 | 11 | 11 | 12 | 13 | 14 | 14 | 16 |
| October .. | 9 | 9 | 9 | 9 | 9 | 9 | 8 | 8 | 9 | 8 | 9 | 10 | 9 | 9 | 9 | 9 | 8 | 7 | 7 | 7 | 8 | 8 | 9 | 9 |
| November .. | 10 | 10 | 11 | 11 | 10 | 10 | 10 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 11 | 11 |
| December .. | 10 | 10 | 10 | 11 | 11 | 12 | 12 | 13 | 12 | 13 | 13 | 12 | 10 | 10 | 9 | 9 | 8 | 8 | 9 | 10 | 9 | 10 | 10 | 10 |
| Mean .. | 14 | 13 | 13 | 14 | 14 | 14 | 13 | 13 | 14 | 13 | 14 | 14 | 13 | 12 | 12 | 12 | 11 | 10 | 11 | 11 | 12 | 12 | 13 | 13 |

## Appendix IV.

KODAIKÁNAL Mean Hourly Bright Sunshine for the year 1909.

| Month. | Hours. | | | | | | | | | | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6–7 | 7–8 | 8–9 | 9–10 | 10–11 | 11–12 | 12–13 | 13–14 | 14–15 | 15–16 | 16–17 | 17–18 | |
| January .. .. | 0·15 | 0·65 | 0·77 | 0·81 | 0·85 | 0·79 | 0·80 | 0·83 | 0·83 | 0·73 | 0·70 | 0·22 | |
| February .. .. | ·14 | ·79 | ·91 | ·96 | ·97 | ·96 | ·89 | ·83 | ·78 | ·69 | ·72 | ·35 | |
| March .. .. | ·12 | ·85 | ·90 | ·93 | ·94 | ·90 | ·85 | ·74 | ·69 | ·61 | ·44 | ·24 | |
| April .. .. .. | ·21 | ·82 | ·93 | ·88 | ·89 | ·72 | ·67 | ·62 | ·56 | ·46 | ·40 | ·28 | |
| May .. .. .. | ·34 | ·65 | ·70 | ·70 | ·74 | ·62 | ·58 | ·53 | ·42 | ·34 | ·30 | ·19 | |
| June .. .. .. | ·23 | ·53 | ·57 | ·64 | ·64 | ·65 | ·49 | ·42 | ·22 | ·20 | ·17 | ·03 | |
| July .. .. .. | ·15 | ·29 | ·32 | ·38 | ·38 | ·39 | ·38 | ·32 | ·25 | ·19 | ·15 | ·10 | |
| August .. .. | ·20 | ·53 | ·56 | ·53 | ·50 | ·44 | ·27 | ·15 | ·12 | ·08 | ·03 | ·02 | |
| September .. .. | ·03 | ·46 | ·67 | ·67 | ·71 | ·60 | ·59 | ·47 | ·30 | ·19 | ·11 | ·06 | |
| October .. .. | ·05 | ·41 | ·60 | ·66 | ·67 | ·45 | ·34 | ·28 | ·31 | ·24 | ·15 | ·05 | |
| November .. .. | ·05 | ·42 | ·69 | ·71 | ·55 | ·54 | ·54 | ·56 | 40 | ·33 | ·17 | ·03 | |
| December .. .. | ·04 | ·43 | ·77 | ·78 | ·77 | ·77 | ·64 | ·57 | ·43 | ·46 | ·27 | ·03 | |
| Mean .. | 0·14 | 0·57 | 0·70 | 0·72 | 0·72 | 0·65 | 0·59 | 0·53 | 0·44 | 0·38 | 0·30 | 0·13 | |

## Appendix V.

NUMBER of days in each month on which the Nilgiris were visible during 1909.

| Month. | Very clear. | Visible. | Just visible. | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January .. .. .. .. | 10 | 7 | 1 | 3 | 21 |
| February .. .. .. .. | 2 | 4 | 6 | 2 | 14 |
| March .. .. .. .. | .. | 3 | 4 | 2 | 9 |
| April .. .. .. .. | .. | 1 | 4 | .. | 5 |
| May .. .. .. .. .. | 1 | 2 | 1 | .. | 4 |
| June .. .. .. .. .. | 5 | 3 | 2 | .. | 10 |
| July .. .. .. .. .. | 1 | 3 | 1 | 1 | 6 |
| August .. .. .. .. | 11 | 9 | 3 | 1 | 24 |
| September .. .. .. .. | 8 | 12 | 3 | 1 | 24 |
| October .. .. .. . | 5 | 3 | .. | .. | 8 |
| November .. .. .. .. | .. | 1 | 1 | .. | 2 |
| December .. .. .. .. | 10 | 5 | 4 | 1 | 20 |
| Total .. | 53 | 53 | 30 | 11 | 147 |

# Appendix VI.

MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1909.

| Abnormals of | January. | February. | March. | April | May. | June. | July. | August. | September. | October. | November. | December. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure .. .. .. | − 0·043 | − 0·019 | − 0·009 | − 0·009 | − 0·019 | − 0·012 | + 0·002 | + 0·010 | − 0·021 | − 0·013 | − 0·021 | − 0·019 | − 0·014 |
| Temperature of air .. .. .. .. .. | + 0·2 | + 0·9 | − 0·2 | − 0·5 | − 0·4 | + 0·1 | − 0·7 | − 0·9 | − 0·8 | + 2·7 | + 2·6 | + 2·3 | + 0·4 |
| Do. of evaporation .. .. .. | + 1·9 | + 1·8 | + 1 0 | + 1·2 | + 1·8 | + 1·2 | + 1·5 | + 2·5 | + 2·1 | + 2·3 | + 1·6 | + 1·9 | + 1·7 |
| Percentage of humidity .. .. .. .. | + 8 | + 4 | + 5 | + 7 | + 8 | + 5 | + 9 | + 14 | + 12 | Same as | − 3 | Same as | + 7 |
| Greatest solar heat *in vacuo* .. .. .. .. | − 6·9 | − 6·3 | − 5·3 | − 6·1 | − 8 5 | − 6·6 | − 12·1 | − 5·8 | − 13·4 | + 0·7 | − 2·4 | − 3·9 | − 5·6 |
| Maximum in shade .. .. .. .. .. | − 0·7 | Same as | − 0·1 | − 1·1 | − 0 4 | − 0·2 | − 0·9 | − 2·2 | − 2·8 | + 4·3 | + 3·9 | + 2·0 | + 0·2 |
| Minimum in shade .. .. .. .. .. | + 0·6 | + 1·5 | − 1·3 | − 0·2 | − 0·6 | − 0·4 | − 1·0 | − 0·4 | − 0 2 | Same as | + 0·6 | + 1·3 | Same as |
| Do. on grass .. .. .. .. | + 1·7 | + 1·9 | − 1·3 | + 0·2 | − 0·8 | Same as | − 0·8 | + 0·2 | Same as | − 0·4 | + 1·1 | + 1·8 | + 0·4 |
| Rainfall in inches .. .. .. .. .. | + 3·41 | − 0·23 | − 0·39 | + 9·69 | + 7·37 | − 0·46 | + 0·99 | + 0·51 | + 3·67 | − 10·39 | − 9·29 | − 4·58 | . |
| Do. since January .. .. .. .. .. | .. | + 3·18 | + 2·79 | + 7·01 | + 17·06 | + 16·60 | + 17·59 | + 18·10 | + 21·77 | + 11·38 | + 2·09 | − 2·49 | − 2·49 |
| General direction of wind .. .. .. .. | 2 points E. | Same as | 1 point E. | 1 point E. | Same as | 1 point W. | 1 point W. | 2 points S. | 3 points W. | 2 points S. | 1 point E. | 2 points E. | Same as |
| Daily velocity in miles .. .. .. .. | − 36 | − 4 | − 40 | − 34 | − 69 | − 37 | − 46 | − 54 | − 27 | − 32 | − 30 | − 16 | − 34 |
| Percentage of cloudy sky .. .. .. .. | − 2 | + 6 | − 2 | + 3 | − 2 | − 5 | − 3 | − 13 | − 2 | − 27 | − 8 | − 17 | − 7 |
| Do. of bright sunshine .. .. .. .. | − 12·6 | − 10·2 | − 8·0 | − 3 1 | − 19·8 | − 14·3 | − 10·5 | − 2·2 | − 9·1 | + 15·5 | − 8·4 | + 1·9 | − 6·9 |

+ Means *above* normal, − *below*.

## Appendix VII.

Abstract of the mean meteorological condition of Madras in 1909 compared with the average of past years.

| Mean values of | 1909. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure .. .. .. .. .. .. | 29·850 | 0·014 below. | 29·864 |
| Temperature of air .. .. .. .. .. .. .. | 81·5 | 0·4 above. | 81·1 |
| Do. of evaporation .. .. .. .. .. .. | 76·2 | 1·7 ,, | 74·5 |
| Percentage of humidity .. .. .. .. .. .. | 79 | 7 ,, | 72 |
| Greatest solar heat *in vacuo* .. .. .. .. .. | 134·1 | 5·6 below. | 139·7 |
| Maximum in shade .. .. .. .. .. .. | 91·0 | 0·2 above | 90·8 |
| Minimum in shade .. .. .. .. .. .. | 74·7 | Same as | 74·7 |
| Do. on grass .. .. .. .. .. .. .. | 72·3 | 0·4 above. | 71·9 |
| Rainfall since January 1st on 86 days .. .. .. .. | 46·58 | 2·49 below. | 49·02 |
| General direction of wind .. .. .. .. .. .. | S.E. | Same as | S.E. |
| Daily velocity in miles .. .. .. .. .. .. .. | 137 | 34 below. | 171 |
| Percentage of cloudy sky . .. .. .. .. .. | 42 | 7 ,, | 49 |
| Do. of bright sunshine .. .. .. .. .. | 51·5 | 6·9 ,, | 58·4 |

Duration and quantity of the wind from different points.

| From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North .. | 137 | 869 | East .. | 323 | 1,544 | South .. | 173 | 1,102 | West .. | 261 | 1,863 |
| N. by E. .. | 189 | 1,101 | E. by S. .. | 292 | 1,540 | S. by W. .. | 190 | 1,026 | W. by N .. | 169 | 1,198 |
| N.N.E. .. | 251 | 1,290 | E.S.E. .. | 338 | 1,427 | S.S.W. .. | 228 | 1,269 | W.N.W. . | 176 | 1,077 |
| N.E. by N. | 391 | 2,393 | S.E. by E. | 448 | 2,019 | S.W. by S. | 205 | 1,154 | N.W. by W. | 111 | 658 |
| N.E. .. | 507 | 3,242 | S.E. .. | 375 | 2,205 | S.W. .. | 231 | 1,378 | N.W. .. | 91 | 425 |
| N.E. by E. | 440 | 2,825 | S.E. by S. | 674 | 4,037 | S.W. by W. | 275 | 1,700 | N.W. by N. | 62 | 348 |
| E.N.E. .. | 309 | 1,891 | S.S.E. . | 368 | 2,458 | W.S.W. .. | 255 | 1,643 | N.N.W. .. | 91 | 526 |
| E. by N. .. | 350 | 1,775 | S. by E. .. | 267 | 1,749 | W. by S... | 290 | 1,912 | N. by W. | 74 | 445 |

There were 219 calm hours during the year. The resultant corresponding to the above numbers is represented by a S.E. by E. wind, blowing with a uniform daily velocity of 28 miles.

# Appendix VIII.

MADRAS OBSERVATORY.—Number of hours of wind from each point in the year 1909.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. | 4 | 17 | 9 | 70 | 58 | 126 | 45 | 65 | 79 | 83 | 53 | 36 | 3 | 32 | 8 | 5 | 1 | 1 | 2 | 1 | .. | 2 | .. | 1 | .. | .. | .. | .. | .. | 3 | 1 | 1 | 38 |
| February .. | 9 | 10 | 25 | 16 | 70 | 51 | 62 | 120 | 64 | 49 | 84 | 41 | 10 | 7 | 4 | .. | 2 | 1 | .. | .. | 3 | 4 | 7 | 2 | .. | 1 | .. | .. | .. | 1 | 1 | 2 | 26 |
| March .. | .. | 3 | 2 | 6 | 49 | 27 | 13 | 4 | 22 | 19 | 24 | 129 | 75 | 210 | 57 | 18 | 9 | 10 | 9 | 16 | 10 | 2 | 3 | 2 | 1 | .. | .. | .. | .. | . | .. | .. | 29 |
| April .. | 4 | 1 | 9 | 1 | 16 | 6 | 15 | 11 | 34 | 8 | 38 | 47 | 133 | 174 | 71 | 31 | 15 | 15 | 26 | 11 | 9 | 15 | 4 | 3 | 4 | .. | 1 | .. | .. | .. | 1 | .. | 17 |
| May .. .. | 6 | 4 | .. | 4 | 4 | 5 | 7 | 8 | 10 | 27 | 23 | 43 | 41 | 78 | 102 | 98 | 31 | 48 | 25 | 38 | 23 | 16 | 12 | 14 | 18 | 17 | 8 | 12 | 3 | 5 | 5 | 4 | 5 |
| June .. .. | 1 | 2 | 2 | 3 | 1 | 1 | .. | 3 | .. | 8 | 11 | 15 | 22 | 18 | 36 | 47 | 38 | 19 | 54 | 35 | 55 | 56 | 66 | 74 | 79 | 31 | 31 | 5 | 5 | 1 | 1 | .. | .. |
| July .. .. | 2 | .. | 1 | .. | .. | .. | 1 | .. | 1 | 2 | 3 | 5 | 8 | 12 | 11 | 30 | 25 | 31 | 38 | 42 | 56 | 102 | 63 | 107 | 59 | 55 | 31 | 17 | 14 | 6 | 8 | 6 | 8 |
| August .. | 10 | 1 | 3 | 1 | 2 | 3 | 2 | 2 | 19 | 11 | 26 | 51 | 44 | 89 | 39 | 11 | 29 | 26 | 33 | 31 | 47 | 37 | 55 | 25 | 30 | 19 | 31 | 18 | 9 | 4 | 12 | 6 | 18 |
| September .. | 4 | .. | 2 | .. | 1 | 2 | 2 | 1 | 9 | 21 | 8 | 31 | 14 | 30 | 24 | 21 | 16 | 34 | 31 | 25 | 21 | 28 | 26 | 43 | 54 | 42 | 59 | 54 | 46 | 28 | 23 | 8 | 12 |
| October .. | 11 | 9 | 45 | 20 | 57 | 40 | 39 | 64 | 57 | 54 | 65 | 50 | 25 | 20 | 6 | 3 | 5 | 2 | 6 | 6 | 4 | 8 | 17 | 17 | 13 | 3 | 9 | 5 | 9 | 4 | 7 | 7 | 57 |
| November .. | 46 | 115 | 93 | 160 | 88 | 70 | 28 | 24 | 13 | 8 | 3 | .. | .. | 4 | .. | 8 | .. | .. | 1 | .. | .. | 1 | .. | 1 | 1 | .. | 4 | .. | .. | 6 | 15 | 27 | 4 |
| December .. | 40 | 27 | 60 | 110 | 161 | 109 | 95 | 48 | 15 | 2 | .. | .. | .. | .. | 10 | .. | 2 | 3 | 3 | .. | 3 | 4 | 2 | 1 | 2 | 1 | 2 | .. | 5 | 4 | 17 | 13 | 5 |
| Annual total .. | 137 | 189 | 251 | 391 | 507 | 440 | 309 | 350 | 323 | 292 | 338 | 448 | 375 | 674 | 368 | 267 | 173 | 190 | 228 | 205 | 231 | 275 | 255 | 290 | 261 | 169 | 176 | 111 | 91 | 62 | 91 | 74 | 219 |

# Appendix IX.

Madras Observatory.—Number of miles of wind from each point in the year 1909.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. .. .. | 20 | 119 | 48 | 284 | 266 | 592 | 238 | 403 | 362 | 456 | 170 | 139 | 14 | 143 | 33 | 25 | 6 | 7 | 8 | 5 | .. | 8 | .. | 4 | .. | .. | .. | .. | .. | 7 | 3 | 1 | 3361 |
| February .. .. .. .. | 43 | 48 | 117 | 136 | 521 | 357 | 352 | 485 | 315 | 254 | 335 | 149 | 60 | 25 | 19 | . | 9 | 2 | .. | .. | 9 | 18 | 23 | 8 | .. | 3 | .. | .. | .. | 1 | 4 | 9 | 3302 |
| March .. .. . .. .. | .. | 17 | 11 | 46 | 151 | 148 | 83 | 23 | 90 | 135 | 129 | 465 | 452 | 1011 | 313 | 61 | 51 | 47 | 47 | 94 | 52 | 6 | 9 | 9 | 4 | .. | .. | .. | .. | .. | .. | .. | 3459 |
| April .. . .. .. .. | 15 | 10 | 48 | 8 | 118 | 80 | 84 | 103 | 172 | 71 | 140 | 285 | 841 | 1326 | 551 | 226 | 115 | 100 | 178 | 80 | 58 | 46 | 17 | 13 | 14 | .. | 7 | .. | .. | .. | 4 | .. | 4710 |
| May .. .. .. . .. | 38 | 21 | .. | 25 | 20 | 25 | 35 | 62 | 73 | 168 | 159 | 297 | 234 | 557 | 663 | 667 | 235 | 303 | 177 | 256 | 160 | 110 | 68 | 89 | 125 | 101 | 49 | 85 | 21 | 25 | 35 | 20 | 4903 |
| June .. .. .. .. .. | 9 | 14 | 19 | 24 | 4 | 6 | .. | 25 | .. | 80 | 90 | 85 | 146 | 158 | 547 | 338 | 239 | 112 | 318 | 206 | 404 | 403 | 535 | 606 | 729 | 265 | 221 | 45 | 36 | 8 | 5 | .. | 5477 |
| July .. .. .. .. . | 13 | . | 6 | .. | .. | .. | 6 | .. | 10 | 14 | 21 | 43 | 58 | 104 | 84 | 207 | 184 | 138 | 188 | 220 | 328 | 662 | 427 | 683 | 440 | 442 | 229 | 113 | 48 | 9 | 26 | 13 | 4716 |
| August .. .. .. . | 41 | 10 | 26 | 11 | 15 | 14 | 16 | 12 | 61 | 52 | 92 | 211 | 259 | 470 | 208 | 93 | 152 | 133 | 153 | 136 | 210 | 224 | 321 | 131 | 143 | 106 | 154 | 103 | 44 | 22 | 48 | 41 | 3712 |
| September .. .. .. .. | 9 | . | 11 | .. | 5 | 4 | 8 | 6 | 40 | 99 | 38 | 149 | 48 | 152 | 143 | 107 | 82 | 167 | 163 | 132 | 119 | 150 | 146 | 280 | 328 | 262 | 351 | 297 | 206 | 195 | 137 | 36 | 3870 |
| October .. .. .. . | 47 | 34 | 149 | 106 | 260 | 180 | 172 | 218 | 267 | 181 | 242 | 196 | 93 | 81 | 34 | 11 | 15 | 10 | 21 | 25 | 16 | 39 | 86 | 81 | 67 | 15 | 48 | 15 | 36 | 13 | 34 | 18 | 2810 |
| November .. .. .. .. | 280 | 692 | 555 | 99 | 680 | 601 | 268 | 115 | 38 | 21 | 11 | .. | | 10 | .. | 14 | .. | .. | 2 | .. | .. | 6 | . | 2 | 4 | .. | 12 | .. | .. | 37 | 84 | 174 | 4598 |
| December .. . .. .. | 354 | 136 | 300 | 761 | 1202 | 818 | 629 | 515 | 116 | 9 | .. | .. | .. | . | 63 | .. | 14 | 7 | 14 | .. | 22 | 28 | 11 | 6 | 9 | 4 | 6 | .. | 34 | 31 | 146 | 133 | 5171 |
| Annual . | 869 | 1101 | 1290 | 2393 | 3242 | 2825 | 1891 | 1775 | 1544 | 1540 | 1427 | 2019 | 2205 | 4037 | 2458 | 1749 | 1102 | 1026 | 1269 | 1154 | 1378 | 1700 | 1643 | 1912 | 1863 | 1198 | 1077 | 658 | 425 | 348 | 526 | 445 | 50089 |

# Appendix X.

MADRAS OBSERVATORY.—Number of inches of rain from each point in the year 1909.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. | .. | .. | .. | .. | 0·16 | 0·27 | 0·33 | 0·95 | 0·49 | 1·45 | 0·27 | 0·38 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| February .. | .. | .. | .. | .. | 0·05 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| March .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| April .. | .. | 0·10 | .. | .. | 0·08 | 1·39 | .. | .. | .. | .. | .. | 0·04 | 0·03 | 2·64 | 0·72 | .. | .. | 1·00 | .. | 0·01 | .. | .. | .. | .. | 0·23 | .. | 1·27 | .. | .. | .. | .. | .. | 0·01 |
| May .. | .. | .. | .. | 0·03 | .. | 0·66 | 0·02 | 1·92 | .. | 1·36 | 0·10 | 1·12 | 1·25 | 0·81 | 0·29 | 1·19 | .. | .. | .. | 0·73 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·01 | .. | .. |
| June .. | 0·02 | .. | .. | .. | 0·02 | .. | .. | 0·98 | .. | .. | 0·02 | .. | 0·01 | .. | 0·04 | 0·07 | 0·03 | 0·08 | 0·05 | 0·10 | .. | 0·16 | .. | .. | .. | .. | 0·04 | .. | .. | 0·03 | .. | .. | .. |
| July .. | 0·12 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·32 | .. | 0·04 | .. | 0·34 | 0·58 | 0·06 | 0·41 | 0·14 | 0·09 | 0·08 | 0·16 | 0·23 | 0·13 | 0·13 | 0·19 | 0·10 | 0·24 | 0·82 | 0·06 | 0·04 | 0·58 | .. |
| August .. | 0·04 | .. | .. | .. | 0·01 | .. | .. | .. | .. | 0·08 | .. | 0·27 | .. | .. | 0·11 | .. | 0·12 | 0 10 | 0·03 | 0·09 | 0·04 | 0 10 | 1·79 | 0·09 | 0·64 | 0·07 | 0·07 | 0·07 | .. | .. | 1·16 | 0·19 | .. |
| September .. | .. | .. | 0·03 | .. | .. | .. | 0·01 | . | 0·37 | .. | 0·06 | .. | 0·19 | .. | .. | 0·02 | 0·03 | 0·05 | 0·02 | 1·07 | 0·04 | 0·02 | 1·62 | 0·13 | 1·75 | 1·37 | 0·32 | 0·18 | 0·10 | 0·30 | 0·60 | 0·06 | 0·02 |
| October .. | .. | 0·01 | 0·01 | .. | 0·35 | 0·04 | .. | .. | 0·16 | 0·03 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·01 |
| November .. | 0·02 | 0·34 | 0·60 | 0·42 | 0·27 | 0·01 | 0·22 | 0·09 | 0·64 | 0·27 | 0·30 | .. | .. | 0·50 | .. | .. | .. | .. | .. | .. | .. | 0·24 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| December .. | 0·05 | 0·05 | 0·16 | .. | .. | 0·04 | 0·14 | 0·05 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·05 | 0·16 | .. |
| Annual .. | 0·25 | 0 50 | 0·80 | 0·45 | 0·94 | 2·41 | 0·72 | 3·99 | 1·66 | 3·19 | 1 07 | 1 81 | 1·52 | 3 95 | 1·50 | 1·86 | 0·24 | 1·64 | 0·24 | 2·09 | 0·16 | 0·68 | 3·64 | 0·35 | 2·75 | 1·63 | 1·80 | 0·49 | 0·92 | 0·39 | 1·86 | 0·99 | 0·04 |

# Appendix XI.

MADRAS OBSERVATORY.—Wind, cloud, and bright sunshine, 1909.

| Month. | Wind resultant. | | Clouds (0—10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H. | 16 H. | 20 H. | Mean. | Average per day. | Greatest number of hours in a day. |
| | MILES. | | | | | | | HOURS. | |
| January .. .. | 69 | E.N.E. | 2·9 | 4·7 | 3·5 | 2·4 | 3·5 | 7·0 | 9·0 |
| February .. .. | 92 | E.N.E. | 2·9 | 3·7 | 3·1 | 2·1 | 3·0 | 8·4 | 10·9 |
| March .. .. | 86 | S.E. | 2·4 | 2·9 | 2·0 | 1·6 | 2·2 | 8·5 | 10·5 |
| April .. .. | 123 | S.E. by S. | 3·8 | 3·9 | 2·3 | 2·3 | 3·1 | 8·6 | 11·3 |
| May .. .. | 98 | S. by E. | 4·2 | 3·7 | 3·6 | 2·9 | 3·6 | 6·0 | 8·8 |
| June .. .. | 116 | S.W. | 5·8 | 5·6 | 6·3 | 5·8 | 5·9 | 4·1 | 7·3 |
| July .. .. | 112 | S.W. by W. | 6·5 | 6·2 | 7·5 | 6·7 | 6·8 | 2·8 | 8·0 |
| August .. .. | 61 | S.W. by S. | 6·0 | 5·8 | 6·1 | 3·5 | 5·4 | 4·8 | 8·6 |
| September .. .. | 60 | W. by S. | 6·4 | 5·6 | 6·9 | 5 1 | 6·0 | 4·2 | 10·6 |
| October .. .. | 45 | E. by N. | 3·0 | 3·2 | 3·9 | 2·5 | 3·2 | 8·0 | 10·7 |
| November . .. | 127 | N.N.E. | 4·4 | 4·8 | 4·6 | 3·8 | 4·4 | 5·6 | 8·9 |
| December .. .. | 140 | N.E. | 3·7 | 4·0 | 4·0 | 2·3 | 3·5 | 6·7 | 8·2 |
| Annual .. | 28 | S.E. by E. | 4·3 | 4·5 | 4·5 | 3·4 | 4·2 | 6·2 | — |

# Appendix XII.

## Mean monthly and annual Meteorological Results at the Madras Observatory in 1909.

| — | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer. Mean. | Dry bulb thermometer. Max. | Dry bulb thermometer. Min. | Dry bulb thermometer. Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. By Blanford's tables. | Relative humidity. By Blanford's tables. | Sun Max. *in vac.* | Min. on grass. | Wind. Daily velocity. | Wind. Mean direction. | | Rain. Amount. | Rain. Days. | Cloudy sky. | Bright sunshine. | Dew point. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | PTS. | | INCHES. | NO. | CENTS. | HOURS. | ° |
| January .. | 29·954 | 0·118 | 75·3 | 83·9 | 68·1 | 15·8 | 71·1 | 67·6 | 0·709 | 81 | 131·5 | 64·8 | 108 | 7 | E. by N. | 4·30 | 5 | 35 | 216·9 | 67·9 |
| February .. | ·946 | ·110 | 77·6 | 86·6 | 69·5 | 17·1 | 72·6 | 69·0 | ·734 | 77 | 133·4 | 65·7 | 118 | 8 | East | 0·05 | 1 | 30 | 235·3 | 69·1 |
| March .. | ·896 | ·123 | 79·8 | 89·3 | 70·8 | 18·5 | 74·9 | 70·7 | ·803 | 79 | 135·2 | 67·3 | 112 | 11 | S.E. by E. | .. | .. | 22 | 263·8 | 71·4 |
| April .. | ·816 | ·129 | 83·5 | 91·8 | 77·0 | 14·8 | 78·8 | 76·0 | ·925 | 81 | 135·6 | 74·9 | 157 | 12 | S. E. | 7·52 | 8 | 31 | 258·1 | 75·7 |
| May .. | ·716 | ·121 | 86·3 | 97·4 | 80·2 | 17·2 | 80·1 | 77·1 | ·914 | 75 | 134·5 | 78·1 | 158 | 15 | S. by E. | 9·49 | 4 | 36 | 186·9 | 76·1 |
| June .. | ·691 | ·121 | 86·5 | 98·1 | 79·9 | 18·2 | 77·8 | 74·7 | ·839 | 67 | 133·9 | 78·6 | 183 | 20 | S. W. | 1·65 | 9 | 59 | 124·2 | 72·2 |
| July .. | ·722 | ·129 | 83·8 | 94·7 | 77·5 | 17·2 | 77·4 | 74·2 | ·857 | 85 | 126·6 | 75·8 | 152 | 21 | S.W.by W. | 4·86 | 16 | 68 | 87·1 | 73·2 |
| August .. | ·758 | ·112 | 82·4 | 91·5 | 76·9 | 14·6 | 78·5 | 75·7 | ·922 | 84 | 134·2 | 75·6 | 120 | 17 | S. by W. | 5·07 | 16 | 54 | 150·2 | 75·9 |
| September . | ·756 | ·120 | 82·2 | 90·4 | 76·9 | 13·5 | 78·4 | 75·4 | ·924 | 84 | 127·9 | 75·0 | 129 | 21 | S.W.by W. | 8·36 | 14 | 60 | 126·7 | 75·9 |
| October .. | ·829 | ·118 | 83·3 | 93·3 | 75·2 | 18·1 | 77·9 | 74·5 | ·887 | 78 | 139·8 | 72·4 | 91 | 9 | E. by S. | 0·61 | 4 | 32 | 247·2 | 74·3 |
| November .. | ·903 | ·113 | 80·1 | 88·9 | 72·9 | 16·0 | 74·5 | 71·7 | ·783 | 76 | 135·0 | 70·6 | 153 | 3 | N.E. by N. | 3·92 | 6 | 44 | 167·9 | 70·7 |
| December .. | ·959 | ·110 | 77·8 | 85·6 | 71·1 | 14·5 | 72·5 | 69·8 | ·730 | 77 | 131·9 | 68·2 | 167 | 4 | N. E. | 0·70 | 3 | 35 | 206·8 | 68·8 |
| Annual .. | 29·829 | 0·109 | 81·5 | 91·0 | 74·7 | 16·3 | 76·2 | 73·0 | 0·838 | 79 | 134·1 | 72·3 | 137 | 12 | S. E. | 46·53 | 86 | 42 | 2,271·1 | 72·6 |

## Extreme monthly Meteorological Records at the Madras Observatory in 1909.

| — | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry bulb thermometer. Highest. | | Dry bulb thermometer. Lowest. | | Wet bulb. Lowest. | | Humidity. Lowest. | | Sun Th. *in vacuo.* Highest. | | Grass therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY. |
| January .. | 30·087 | 11 | 29·761 | 1 | 0·326 | 87·3 | 29 | 64·5 | 19,25 | 64·2 | 11 | 44 | 10 | 138·8 | 25 | 60·7 | 25 | 312 | 1 | 52 | 8 | 1·81 | 1 |
| February .. | ·096 | 11 | ·822 | 25 | ·274 | 89·4 | 16 | 66·2 | 27 | 65·8 | 13 | 55 | 12, 13 | 138·2 | 16 | 62·1 | 27 | 197 | 18 | 62 | 23 | 0·05 | 18 |
| March .. | ·031 | 27 | ·748 | 9 | ·283 | 97·4 | 31 | 66·3 | 6 | 66·3 | 6 | 45 | 1 | 142·3 | 31 | 62·7 | 13 | 152 | 19 | 69 | 14 | .. | .. |
| April .. | 29·961 | 15 | ·676 | 19 | ·285 | 98·0 | 27 | 68·4 | 12 | 68·4 | 12 | 57 | 1, 4 | 140·5 | 4 | 68·4 | 12 | 239 | 18 | 104 | 12 | 2·57 | 12 |
| May .. | ·874 | 18 | ·562 | 31 | ·312 | 106·1 | 30 | 74·2 | 5 | 73·7 | 21 | 43 | 21 | 143·6 | 27, 28 | 68·2 | 16 | 222 | 20 | 95 | 11 | 5·42 | 4 |
| June .. | ·870 | 15 | ·476 | 5 | ·394 | 102·9 | 9 | 69·5 | 15 | 69·4 | 15 | 35 | 8 | 144·0 | 22 | 70·1 | 15 | 257 | 5 | 97 | 15 | 1·03 | 15 |
| July .. | ·919 | 22 | ·585 | 12 | ·334 | 102·2 | 18 | 71·7 | 23 | 71·2 | 23 | 34 | 18 | 142·2 | 19 | 70·3 | 23 | 215 | 9 | 80 | 1 | 1·62 | 22 |
| August .. | ·869 | 15 | ·622 | 21 | ·247 | 96·5 | 1, 2 | 73·2 | 20 | 72·8 | 1 | 45 | 1 | 141·3 | 10 | 72·3 | 19, 20 | 189 | 2 | 69 | 28 | 1·43 | 19 |
| September .. | ·888 | 28 | ·616 | 4 | ·272 | 96·0 | 20 | 72·1 | 12 | 72·1 | 12 | 53 | 18 | 143·8 | 28 | 72·1 | 12 | 205 | 2 | 64 | 8 | 2·67 | 1 |
| October .. | ·955 | 29 | ·707 | 9 | ·248 | 98·1 | 6 | 68·7 | 27 | 68·3 | 27 | 42 | 27 | 149·6 | 29 | 65·2 | 26 | 128 | 14 | 69 | 16 | 0·35 | 13 |
| November .. | 30·015 | 10 | ·790 | 20 | ·225 | 93·9 | 2 | 67·2 | 12 | 66·6 | 12 | 51 | 6 | 145·8 | 13 | 63·8 | 12 | 239 | 29 | 85 | 27 | 2·53 | 26 |
| December .. | ·104 | 29 | ·705 | 4 | ·399 | 90·4 | 4 | 65·5 | 27 | 64·9 | 27 | 56 | 25 | 136·5 | 5 | 62·1 | 27 | 277 | 28 | 90 | 5 | 0·32 | 24 |

# KODAIKÁNAL AND MADRAS OBSERVATORIES.

## REPORT FOR THE YEAR 1910.

CONTENTS.

# KODAIKÁNAL AND MADRAS OBSERVATORIES.

## I.—REPORT OF THE KODAIKÁNAL OBSERVATORY FOR THE YEAR 1910.

**Staff.**—The staff of the Observatory on the 31st December 1910 was as follows :—

| | |
|---|---|
| Director .. .. .. .. | C. Michie Smith, C.I.E., B.Sc. |
| Assistant Director .. .. .. | J. Evershed. |
| First Assistant .. .. .. | S. Sitarama Aiyar, B.A. |
| Second Assistant .. .. .. | G. Nagaraja Aiyar. |
| Third Assistant .. .. .. | A. Y. Subrahmanya Aiyar, B.A. |
| Fourth Assistant .. .. .. | S. Balasundaram Aiyar. |
| Writer .. .. .. .. | L. N. Krishnaswamy Aiyar. |
| Photographic Assistant .. .. | R. Krishna Aiyar. |

The Assistant Director was on privilege leave from May 20 to August 19. The appointment of a temporary extra assistant was sanctioned for four months from April 23, and Mr. T. R. Raghunatha Rao, B.A., was appointed to the post. His services were retained as acting third assistant from August 19 to December 23 during the successive absences on privilege leave of the first, second, and third assistants. The writer and the photographic assistant were on privilege leave from July 27 to December 28.

The subordinate staff consists of a book-binder, a book-binder's boy, a mechanic, five peons, a boy peon for the dark room, and two lascars.

2. **Distribution of work.**—The distribution of work amongst the staff was the same as last year.

3. **Buildings and grounds.**—Plans and estimates have been prepared and forwarded to the Government of India, for sanction, for the construction of a house for the photographic assistant who has at present to live at a distance of three miles from the Observatory.

There has been much delay in connection with the electric installation for the Observatory, but a revised estimate has recently been sanctioned by the Government of India and it is hoped that the work will be begun early in 1911.

About 1,000 young seedlings, chiefly pines, were planted during the year. Those formerly planted have made remarkably good progress and if fire can be kept out they will soon form a most valuable screen. The old fire lines have been broadened and new ones cut. During the year fires from the outside have been successfully warded off, but one fire lighted inside—evidently maliciously—destroyed 50 young trees before it could be extinguished.

4. **Instruments.**—The following are the principal instruments belonging to the Observatory, or in use, at the present time :—

Six-inch Cooke equatorial.

Six-inch Lerebour and Secretan equatorial remounted by Grubb with a five-inch Grubb portrait lens of 36 inches focus attached.

Spectrograph I.—consisting of slit, collimator lenses of 4 and 7 feet focus, 2-inch parabolic grating, and camera tube without lens. Used in connection with an 11-inch polar siderostat and 6-inch Grubb lens of 40 feet focus.

A rhomb with ends cut at 45° mounted on a graduated circle can be placed in front of the slit so as to enable any part of the limb to be brought on to the slit.

Spectrograph II.—Spectrograph II. has been dismantled, the grating is used in spectrograph III.

Spectrograph III.—consisting of slit provided with vertical and horizontal millimetre scales for measuring position angles, and a reflecting device for rotating the sun's image, collimator lens of 210 c.m. focus, 6-inch Michelson grating, and camera lens of about 4 metres focus. The spectrograph is used with the 18-inch concave mirror.

Spectroheliograph—with 18-inch siderostat and 12-inch Cooke photo-visual lens of 20 feet focus, by the Cambridge Scientific Instrument Company.

An auxiliary spectroheliograph attached to the above, made in the Observatory workshop.

Six-inch transit instrument and barrel chronograph, formerly the property of the Survey of India.

Six-prism table spectroscope—Hilger.

Photoheliograph Dallmeyer No. 4.

Theodolite, six-inch—Cooke.

Sextant.

Evershed spectroscope with three prisms for prominence and sunspot work, by Hilger.

Mean time clock, Kullberg 6326.

Do. Shelton.

Mean time Chronometer, Kullberg 6299.

Sidereal chronometer, Kullberg 6134.

Tape chronograph, Fuess.

Micrometer for measuring spectrum photographs, Hilger.

Dividing engine, Cambridge Scientific Instrument Company, Limited.

Two Balfour Stewart actinometers.

Buchanan's solar calorimeter.

Induction coil with necessary adjuncts.

Small polar siderostat.

Universal instrument.

Complete set of meteorological instruments, including Richard barograph and thermograph, and wind recorders.

A high class screw cutting turning lathe by Messrs. Cooke & Sons.

Ångström Pyrheliometer.

An 18-inch concave mirror by Henry of Paris belonging to the Assistant Director has been mounted in the spectroheliograph room for general spectrum work and for large scale photographs of sunspots.

Sanction having been obtained for sending home the 18-inch mirror of the spectroheliograph to be refigured, an application was made to the Joint Eclipse Committee for the loan of a mirror. This was kindly granted and one of the eclipse cœlostats with a 16-inch mirror was sent out. This was used while the 18-inch mirror was away, except for a short time when the cœlostat was fitted up for taking photographs of Halley's comet. During this time the 11-inch mirror belonging to the 40-foot spectrograph was used. The 18-inch mirror was returned on September 27 greatly improved.

## OBSERVATIONS.

### (*a*) Solar Physics.

5. The following table shows for each day the solar observations that were made :—

# Table A.

## Solar Observations in 1910.

A = Spots observed. B = Spot spectra. C = Prominences. D = Photoheliograms. E = Spectroheliograms.

| Date. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 .. | A—CDE | A—*C*DE | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | A—*C*DE | A—CDE | ABCDE | A—CD*E* | A—CDE |
| 2 .. | A*B*CDE | A—*C*DE | A—CDE | A—CDE | A—CDE | A—CDE | A——D*E* | A—*C*DE | A—CDE | A—CDE | A——D*E* | A—CDE |
| 3 .. | A—*C*D*E* | A——DE | A—CDE | A—CDE | A—CDE | A—CDE | A——D*E* | A—*C*—— | A——D*E* | A—CDE | A———— | A—CDE |
| 4 .. | A——D*E* | A—*C*DE | ABCDE | A—CDE | A—CDE | A—CDE | A——D*E* | A——D— | — | A—CDE | A——D*E* | A—CDE |
| 5 .. | A———— | A—CDE | ABCDE | A—CDE | A—CDE | A—CDE | A—*C*D*E* | A—CD— | A——D*E* | ABCDE | A—CDE | A—CDE |
| 6 .. | AB*C*DE | A—CDE | ABCDE | A—CDE | A——D*E* | A—*C*DE | A——D*E* | A—CDE | A—*C*DE | ABCDE | — | A—CDE |
| 7 .. | A—CDE | A—CDE | ABCDE | A—CDE | A—*C*DE | A—*C*DE | A——D— | A—*C*D*E* | A—CDE | A—*C*DE | A——D— | A—CDE |
| 8 .. | A—CDE | A—CDE | A—CDE | A—*C*DE | A—*C*DE | A——D*E* | AB*C*DE | A—*C*DE | A—CD*E* | A—CDE | A—CDE | A—CDE |
| 9 .. | A—*C*DE | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | A——D*E* | ABCDE | A—*C*D*E* | A—CDE | A—CDE | A—CDE |
| 10 .. | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | A—*C*DE | A—CDE | ABCDE | A—CDE | A—*C*DE | A—CDE | A—CDE |
| 11 .. | A—CDE | A—CDE | A—*C*DE | A—CDE | A—CDE | A——D*E* | A—CDE | A—*C*D*E* | A—*C*DE | A—CDE | A—CD— | A—CDE |
| 12 .. | ABCDE | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | ABCDE | A—CDE | A—CDE | A——D— | A—CDE |
| 13 .. | A—*C*D*E* | A—CDE | A—CDE | A—CDE | A—*C*DE | A—CDE | A—CDE | A—CD*E* | A—*C*DE | A—CDE | A—*C*DE | A—CDE |
| 14 .. | A—*C*DE | ABCDE | A—CDE | A—CDE | A—CDE | A—CDE | A—*C*DE | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE |
| 15 .. | ABCDE | ABCDE | A—CDE | A—CDE | A—CDE | A—*C*DE | A—*C*DE | A—*C*DE | A—CDE | A—CDE | A——D— | A—CDE |
| 16 .. | A—*C*DE | ABCDE | A—CDE | A—*C*DE | ABCDE | A——D*E* | A—*C*DE | A—CDE | A—CDE | A—*C*D*E* | A—CDE | A—CDE |
| 17 .. | ABCDE | ABCDE | A—CDE | A—CDE | ABCDE | A——D*E* | A—CDE | A—CDE | A—*C*D*E* | A—CDE | A——DE | A—CDE |
| 18 .. | A—CDE | A——D*E* | A—CDE | A—CDE | A*B*CDE | A—*C*DE | A—*C*DE | A—*C*DE | A—CDE | A———— | A—CDE | A—CDE |
| 19 .. | A—CDE | A—*C*D*E* | A—CDE | A—CDE | A—CD*E* | A—*C*D*E* | A—CDE | A——D— | A—CDE | A—CDE | A—CDE | A—CDE |
| 20 .. | A—CDE | A—CD*E* | A—CDE | A—CDE | A—CDE | A—*C*DE | A—*C*DE | A——D*E* | A—CD*E* | A—CDE | A—CDE | A—CDE |
| 21 .. | A—CDE | ABCDE | A—CDE | A—CDE | A—CDE | *A*———— | A—*C*DE | A—CDE | A—*C*DE | A—CD*E* | A—CD*E* | A—CDE |
| 22 .. | A—CDE | A—*C*DE | A—CDE | A—CDE | ABCDE | *A*———— | A—CDE | A—*C*DE | A—*C*DE | A——D*E* | A—*C*DE | A—CDE |
| 23 .. | A*B*CDE | A—CDE | A—CDE | A—CDE | ABCDE | *A*———— | A———*E* | A—CDE | A—*C*DE | A——D*E* | A—CDE | A—CDE |
| 24 .. | A—CDE | ABCDE | A—CDE | A—CDE | A—CDE | *A*———— | A—CDE | A—*C*DE | A—*C*D*E* | A—CDE | A—CDE | A—CDE |
| 25 .. | ABCDE | AB*C*DE | A—CDE | A—CDE | A—CDE | — | A—CDE | A—CDE | A——D— | A—CDE | A—CDE | A—CDE |
| 26 .. | A—CDE | ABCDE | A—CDE | A—CDE | A—CDE | A—*C*DE | A—*C*DE | A——D*E* | A—CDE | A—CDE | A—CDE | A—CDE |
| 27 .. | ABCDE | ABCDE | A—CDE | A—CDE | A—CDE | A—CDE | ————*E* | — | A—CDE | A—*C*DE | A—CDE | A—CDE |
| 28 .. | ABCDE | A—CDE | A—CDE | A—CDE | A—*C*DE | — | — | A———*E* | A—*C*D*E* | — | A—CDE | A—CDE |
| 29 .. | A——D— | | A—CDE | A—CDE | A—CDE | A—*C*DE | — | A—*C*D*E* | A—*C*DE | A——D— | A—CDE | A—CDE |
| 30 .. | A—*C*DE | | A—CDE | A—CDE | A—CDE | A—CDE | A——D— | A—*C*D*E* | AB*C*DE | A——D— | A—CDE | A—CDE |
| 31 .. | A—CDE | | A—CDE | | A—CDE | | A—CD*E* | A—*C*DE | | A—CDE | | — |

*Note.*—When a letter is in italics, it means that on that day the observations were not complete

SOLAR Observations—Abstract.

| — | 1910. January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 31 | 28 | 31 | 30 | 31 | 28 | 28 | 30 | 29 | 30 | 29 | 30 | 355 |
| B | 9 | 9 | 4 | .. | 5 | .. | 1 | 3 | 1 | 3 | .. | .. | 35 |
| C | 28 | 26 | 31 | 30 | 30 | 20 | 20 | 25 | 26 | 25 | 22 | 30 | 313 |
| D | 30 | 28 | 31 | 30 | 31 | 24 | 27 | 28 | 29 | 29 | 28 | 30 | 345 |
| E | 29 | 28 | 31 | 30 | 31 | 24 | 27 | 26 | 28 | 27 | 24 | 30 | 335 |

Though the year was one of heavy rainfall during the summer months it was not unfavourable for solar observations in the morning hours, and there were only ten days on which no observations were possible.

6. **Photographs of the sun** with the Dallmeyer photoheliograph were taken on 345 days as against 332 in 1909. Even in June, when the defect was greatest, they were lost on only 6 days. Double exposures are taken twice a month for determining the error of orientation of the photographs. The Greenwich Observatory asked for only 2 solar negatives to complete its series and of these only one could be supplied.

7. **Observations of sunspots.**—The sun is examined for spots and faculae every morning when the weather permits. The sun's image is projected on an 8-inch disc and the positions of spots and faculae are marked on it. The discs are prepared by the cyanotype process from the large scale drawings of Father R. de Beaurepaire, as mentioned in last report.

8. **Sunspot spectra.**—(*a*) *Visual.*—This work is done in accordance with the suggestions issued by the committee of the International Union for Solar Research. It includes the comparison of the spot spectrum with a standard map for the region 5210 to F., a detailed study of C and $D_3$, and observations of variations in intensity of the following iron lines :—5383·58, 5397·34, 5404·36, 5405·99, 5424·29, 5429·91, 5445·26, 5447·13, 4924·11, 5234·79, 5316·79 and 5535·06. This work was possible on only 35 days owing to the small number of large spots visible during the year.

(*b*) *Photographic.*—Studies in connection with the radial movement of the gases over sunspots have been continued and a large number of photographs of spot spectra have been obtained. Particular attention has been paid to the behaviour of the C line of hydrogen and this line has been found to be almost always inclined over spots, the inclination being towards the violet on the side of the spot nearest the limb and towards the red on the side nearest the centre of the disc. This shows that the hydrogen in the higher regions of the chromosphere is drawn inwards towards the umbrae of spots, sharing in the movement which had already been detected in the case of calcium vapour, and opposed to the movement of the low level gases of the reversing layer.

Measures of the displacements of the lines $H_3$ and $K_3$ have been made showing the inward movement to be of the same order of magnitude as the outward motion of the low level gases.

The relatively slow rotational movement in spots, evidence of which was mentioned in the last report, has been confirmed by measures of the displacements of the lines in three northern and three southern spots ; and the direction of rotation in these instances has been found to be opposite in the two hemispheres.

The rotational or spiral movement has not so far been found to affect the inflowing gases of the higher chromosphere, but owing to the width of the hydrogen and calcium lines such motion would be very difficult to detect.

A general discussion of the radial and rotational movements in spots has been published in the monthly notices of the Royal Astronomical Society, Vol. LXX.

A long series of photographs has been obtained of the H and K region of the spectrum for the purpose of detecting movements in a vertical direction of calcium vapour in and near spots. Measurements of these plates are in progress.

A few measures have been made of the Zeeman separations of a line in the red region which is doubled in sunspots ; and some lines in the ultra violet which are normally single in spots have been recorded on one plate as doubled at a time when a great eruption of gases was in progress. This indicates that a greatly increased magnetic field may accompany such outbursts.

9. **General spectroscopic work.**—A series of photographs of the H and K lines in prominences and of the hydrogen line C have been obtained with spectrograph III. using the Rowland $3\frac{1}{4}$ inch grating. These are being measured for the purpose of determining the angular speed of rotation of the prominences at various heights above the sun's limb. A comparison spectrum of the centre of the sun's disc is impressed on each side of the prominence spectrum on every plate, and determinations of the wave-length of the H and K absorption lines at the centre of the disc are also made. The results will be discussed when sufficient material has been obtained.

Photographs of the spectrum of Halley's comet were obtained on 22 mornings from April 18 to May 16 inclusive, using a prismatic camera of 1·7 inch aperture attached to the South dome equatorial. The best plates of the series have been measured and the results published in Bulletin No. XX. and in the Monthly Notices of the Royal Astronomical Society, Vol. LXX.

**Laboratory work.**—The spectrum of glowing iodine vapour heated externally in a quartz tube has been photographed and the apparently anomalous nature of the emission spectrum has been proved to be a subjective phenomenon, the heated vapour giving a banded emission spectrum identical with the absorption spectrum photographed under the same conditions.

10. **Prominences.**—Prominences were recorded visually on 312 days as against 309 in 1909, but on 65 days the combined visual and photographic record was imperfect owing to unfavourable weather conditions. June and July were, as usual, the most defective months. In June complete prominence records were obtained on only eight days. The record of the prominences is made round the disc on which spots and faculae have been projected and with the discs now in use the apparent positions of prominences are easily read off directly. The visual record is compared with the spectroheliograms and all prominences shown in the photographs but not in the drawing, as well as conspicuous extensions of calcium prominences inside the disc of the sun, are added in blue pencil. Where there is much difference between the photograph and the drawing the differences are noted. In the case of eruptive or metallic prominences the spectra are examined, the most conspicuous bright lines are recorded, and all large displacements of the C line are also noted and their amounts estimated.

11. **Work with the spectroheliograph.**—Photographs of the sun's disc in $K_2$ light were obtained on 335 days, and limb photographs showing the prominences on 289 days. A few plates were also obtained with the camera slit set at the cyanogen radiation at $\lambda$ 3883. These show faculæ very clearly, the images resembling those taken in the stronger iron lines. On May 19 the disc was photographed in the cyanogen radiation in an attempt to show the head of Halley's comet in transit, but no trace of the comet can be seen on the plates.

The best disc plate of each day has been copied on an enlarged scale on bromide paper as heretofore, the prints so obtained being oriented and pasted in order on card sheets for convenience of reference. The best limb plates have been measured and the position angles and heights of all prominences recorded.

A few photographs of the sun's disc in H$\alpha$ light have been obtained with the auxiliary spectroheliograph using the 6-inch Michelson grating. The photographs, although underexposed, show the dark flocculi due to prominences in projection on the disc. Owing to the long exposures needed it has been decided to substitute prisms for the grating and two large prisms of 45° angle have been kindly lent for this purpose by Professor Naegamvala of the Poona Observatory. At the end of the year the prisms had been mounted and new slits made of the necessary curvature.

Prominence spectroheliograms for 52 days were received from the Solar Observatory, South Kensington, and flocculi plates for 335 days were sent in exchange.

12. **Solar Radiation**.—Observations with the Ångström pyrheliometer were made on only a few days. This was partly owing to the great pressure of other work and partly to the feeling that under present conditions time spent on this was largely wasted as there are no means available of standardizing the instrument.

The method of estimating changes in the solar radiation by comparing the intensity of moonlight with first type stars has now become part of the routine work, and photographic comparisons are made whenever the atmospheric conditions permit. Owing to the rarity of perfectly uniform skies comparisons are now made not only near full moon, but also at any phase between half and full. A separate investigation is required to determine the exact relations between phase and intensity.

During the year comparisons were obtained in the January, March, April, and December lunations and the stars used were Alpherat, Rigel, Sirius, Procyon, and Regulus, all assumed to be invariable in their light.

A special photometer is under construction for the measurement of the plates

*Summary of Results.*

13. **Sunspots.**—The following table shows the monthly numbers of new groups observed, the mean daily numbers of spots visible, and the distribution between the northern and southern hemispheres :—

| — | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups .. .. | 17 | 9 | 9 | 13 | 14 | 14 | 16 | 7 | 14 | 17 | 13 | 9 | 152 |
| Daily number .. .. | 3·5 | 2·1 | 1·9 | 1·3 | 2·2 | 1·2 | 1·5 | 1·0 | 2·3 | 2·4 | 1·0 | 0·9 | 1·8 |
| North .. .. .. | 6 | 2 | 4 | 6 | 4 | 4 | 5 | .. | 2 | 4 | 7 | 2 | 46 |
| South .. .. .. | 11 | 7 | 5 | 7 | 10 | 10 | 11 | 7 | 12 | 13 | 5 | 7 | 105 |
| Equator .. . | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | 1 |

The most notable feature of the year was the rapid decrease in spot activity as indicated by the following figures :—

| | 1909. | 1910. |
|---|---|---|
| Number of new groups .. .. .. .. .. | 220 | 152 |
| Mean daily numbers .. .. .. .. .. .. | 3·9 | 1·8 |
| Large spot groups .. .. .. .. .. .. | 45 | 15 |
| Spot returns .. .. .. .. .. .. | 22 | 6 |
| Number of days on which no spots were seen .. .. | 5 | 56 |

The number of new groups in 1907 and 1908 were respectively 301 and 262. The very abrupt decline in spot activity in 1910 is especially shown by the large proportion of days on which the sun's disc was free from spots at the time of observation.

The proportion of southern spots to northern, which has been increasing since 1906, was highest in 1910, *i.e.*, 105 to 46. The mean latitudes in the two hemispheres were 7°·2 north and 9°·6 south—closer to the equator by about 1°½ than in 1909. The highest latitudes were 18° in the northern hemisphere in March and 20° in the southern in February.

The following were the most important spot groups seen during the year :—

*January*—

Nos. 1804, 1806, 1811, 1813 These contained fairly large spots.

*February*—

Nos. 1816, 1819 Group No. 1819 occupied 10° in longitude and 7° in latitude and was made up of several large and numerous small spots.

*March*—

Nos. 1825, 1829, 1830, 1832 contained fairly large spots.

*May*—

No. 1855 was a large and active group and underwent much change from day to day. The C line was frequently observed to be reversed and displaced. The greatest disturbance was observed on the 17th; the maximum was displacement 2 Å to red in F.

*July*—

No. 1875 was first seen at the east limb as a group of two small spots, the leader soon developed into a large spot of round and regular outline.

*August*—

No. 1891 contained a large but quiescent spot.

*September*—

No. 1911 was the second return of group No. 1891 observed early in August. During its two previous apparitions it contained spots of round and regular outline but now had developed into an extensive, broken group covering about 18° of longitude and 10° of latitude. C was frequently observed reversed and $D_3$ was dark in the spot region. Eruptive prominences were observed on the limb of the sun when the group was close to it.

*October*—

No. 1915 was first seen as a small spot and subsequently developed into a large spot of round and regular outline. After crossing the central meridian it broke up into an irregular group of fairly large but scattered umbral and penumbral patches. Disturbance was indicated in the spot region on several days by the reversal of the C line and the darkening of $D_3$.

14. **Prominences.**—Notwithstanding the great reduction of spot activity compared with 1909 the prominences, as estimated by profile areas, show a diminution of only 1 per cent., while there was an actual increase in the average daily number.

The activity for the two hemispheres compared with 1909 is given in the following table :—

*Mean daily profile Areas of Prominences.*

| | 1909. Square minutes. | 1910. Square minutes. |
|---|---|---|
| North .. .. .. .. .. .. | 2·10 | 2·03 |
| South .. .. .. .. .. . | 2·04 | 2·07 |
| Total .. | 4·14 | 4·10 |

The distribution in latitude has been practically the same as in 1909. There was a tendency during the first six months to form two zones of activity in each hemisphere separated by a less active zone between the parallels of 30° and 40°. Later, the distribution became more uniform from the equator to latitude 60° north and south. Beyond 60°, in the polar areas, small and very transient jets have been frequently recorded.

Metallic prominences have been infrequent, only 33 having been observed during the year. The high latitudes recorded for some of these is an unusual feature and shows that these prominences are not invariably associated with spots. The mean and extreme latitudes observed are given in the following table :—

*Metallic Prominences*

| — | Number observed. | Mean latitude. | Extreme latitude. | |
|---|---|---|---|---|
| North .. .. .. | 10 | 28°·2 | 2° | 76° |
| South .. .. .. | 23 | 17°·7 | 2° | 83° |

The prominence activity in each month may be estimated from the following table :—

*Numbers of Prominences.*

| Month. | Prominences one minute or more in height. | Metallic. | Eruptive. |
|---|---|---|---|
| January .. .. .. .. | 45 | 3 | 7 |
| February .. .. .. .. | 44 | 2 | 5 |
| March .. .. .. .. | 70 | 7 | 4 |
| April .. .. .. .. | 53 | 6 | 3 |
| May .. .. .. .. | 56 | 7 | 4 |
| June .. .. .. | 29 | 1 | 3 |
| July .. .. .. .. | 27 | .. | 4 |
| August .. .. .. .. | 18 | .. | 2 |
| September .. .. .. .. | 36 | 1 | 4 |
| October .. .. .. .. | 54 | 2 | 6 |
| November .. .. .. . | 37 | 1 | 4 |
| December .. .. .. .. | 54 | 3 | 4 |

The following were the more noteworthy prominences observed during the year :—

*January.*—The tallest prominence of the month was photographed at + 33° west on the 15th. It was a slanting streak 210″ high which underwent some changes of form and soon disappeared. The spectrum of a prominence observed near the west limb on the 7th, associated with spot No. 1793, showed considerable motion in the line of sight, both towards and away from the observer, and the form of the prominence underwent great and rapid changes. The calcium photographs show a remarkable series of slender arched filaments.

*February.*—The tallest prominence of the month was only 165″ high but covered 20° of the limb.

*March.*—A strongly eruptive prominence was recorded at the west limb on the 1st. Its height varied from 15″ at $8^h\ 0^m$ to 70″, 345″, 295″, 165″ and 60″ at $8^h\ 10^m$, $8^h\ 48^m$, $9^h\ 13^m$, $9^h\ 49^m$ and $10^h\ 30^m$ respectively; there were corresponding changes in the form also. The hydrogen lines at the base were displaced, corresponding to a velocity towards the observer of 75 miles a second. Large prominences continued to be visible at the same position angle for a week. From the 17th to the 19th the

east limb was covered by a group which extended for more than 35°. This group was remarkable for its long life; the phtographic records show it on alternate limbs during three rotations of the sun, and it was also photographed as an absorption marking when near the central meridian during three successive apparitions.

*April.*—The tallest prominence of the month was only 135″ high.

*May.*—On the 25th a series of connected prominences was recorded extending from — 24° west to + 23° west. They were changing both in shape and height, the greatest height reached was 200″, which was the greatest also for the month.

*June.*—One very high prominence was photographed on the 20th at latitude + 36° west. At $10^h\ 4^m$ it was a detached pillar 420″ high with the base 240″ above the limb. By $10^h\ 22^m$ the whole prominence had risen bodily 30″. Bad weather prevented further observations.

*July.*—The largest prominence observed in the month was an eruptive one which during its rapid changes attained a maximum height of 170″. It was observed on the 11th.

*August.*—No prominence recorded in the month exceeded 90″ in height.

*September.*—The tallest prominence recorded was a slender streak 210″ high on the 30th.

*October.*—The tallest prominence recorded was only 200″ high, but there was on the whole a marked increase of prominence activity during the month.

*November.*—The tallest prominence of the month was only 165″ high. On the 19th a metallic prominence was observed which showed some disturbance.

*December.*—The highest prominence of the month, recorded on the 20th, was 225″ high.

(*b*) Other Observations.

15. The daylight Comet, 1910*a*, was picked up readily with the naked eye soon after the receipt of the telegram announcing its discovery. It was observed with the Lerebour and Secretan equatorial on January 17, 18, and 19 and meridian transits were obtained on the 18th and 19th. After it became an evening object the weather was very cloudy and no photographs could be obtained. The results of the observations were communicated to the *Astronomische Nachrichten* (No. 4392).

16. **Halley's Comet.**—Halley's comet made a magnificent display as it approached the earth during the second and third weeks of May, and it was also a conspicuous object on and after April 18 when it was first seen as a morning star. Arrangements had been made to photograph it with the instruments available and the following series were secured:—

(1) Direct photographs taken with the Grubb lens; scale $1^{mm} = 3'\cdot96$.

(2) Direct photographs taken with a Ross lens; scale $1^{mm} = 17'\cdot5$.

(3) Direct photographs taken with a reflector $9\frac{1}{4}$ inches aperture, 74 inches focal length; scale $1^{mm} = 110''$.

(4) Direct photographs on a small scale taken with two small cameras.

(5) Spectrum photographs with a prismatic camera with two 60° prisms, 1·7 inches effective aperture and lens of 11·5 inches focus.

(6) Visual and photographic observations during the transit across the sun's disc on May 19.

(7) Visual observations on the mornings of May 20 and 21.

The weather, though not by any means perfect, was quite as favourable as could be expected at the season and from April 19 to May 16 there were only six days on which no photographs could be obtained.

The results were on the whole good and have been published in detail in Bulletin No. XX. of this observatory.

17. **Time.**—The error of the standard clock is usually determined by reference to the $16^h$ signal from the Madras Observatory. This is rendered possible by the courtesy of the Telegraph Department which permits the Madras wire to be joined through to this observatory. The signal is received with accuracy on most days and all failures are at once reported to the officer in charge of the Trichinopoly division. Time determinations are made with the transit instrument, when necessary, as a check.

18. **Meteorology.**—Meteorological observations were carried on as in former years. Eye observations are made at $8^h$, $10^h$, and $16^h$ local mean time. Temperatures and pressures are recorded continuously by a Richard thermograph (wet and dry bulb) and barograph, and the mean temperature and pressure are obtained from the traces, corrected by reference to the eye observations. The wind direction and velocity are obtained from a Beckley anemograph.

*Pressure.*—The mean pressure for the year was 0·020 in below normal. It was normal in December above normal in February and May and below in all other months. The highest mean daily pressure recorded was 22·923 on December 26 and the lowest 22·614 on June 24.

*Temperature.*—The mean temperature of the year was 0°·1 above normal. The defect in February amounted to 1°·1 and the excess in December to 2°·9; in no other month did the difference from normal exceed 0°·8. The highest shade temperature recorded was 75°·4 on April 1 and the lowest 40°·8 on February 8th and December 17th. The lowest temperature shown by the grass minimum was 16°·3 on December 17th.

*Humidity.*—The mean humidity for the year was 3% below normal. It was below normal from January to May and in November and December and above it for the rest of the year. The defect in December amounted to 29%.

*Rain.*—The rainfall for the year was largely above normal (12·25 inches). The fall was considerably in defect for the first four months of the year and in September, and largely in defect in December. It was largely in excess in all the other months. The greatest fall on any one day was 3·62 inches on November 16.

*Wind.*—On the average for the year the wind was nearly normal in both direction and strength. The strength was considerably in excess in February, April, September, and December and considerably in defect in July, October, and November. The only months in which the direction differed largely from the normal were July when it was 5 points more northerly and October when it was 7 points more westerly than usual. The largest amount of wind on any one day was 800 miles on July 3, and the smallest amount 96 miles on November 14.

*Transparency of the atmosphere.*—The transparency of the lower atmosphere as judged by the visibility of the Nilgiris, about 100 miles distant, was again below average though somewhat better than in 1909.

*Cloud and Sunshine.*—The year as a whole was somewhat less cloudy than usual. There were 2,117 hours of bright sunshine against an average for the last 11 years of 2,028.

19. **Seismology.**—The Milne horizontal pendulum worked well throughout the year and 81 earthquakes, many of them large, were recorded.

20. **Library.**—One hundred and sixty-eight volumes were bound during the year.

21. **Publications.**—Bulletins Nos. XIX. to XXII. were published during the year and No. XXIII. was in type at the end of the year. Bulletins Nos. XIX. and XXI. deal with observations of prominences, No. XX. with the observations of Halley's comet, and No. XXII. with the magnetic field in the sunspot of September 1909. In addition to these the following papers were published:—

"Observations of Comet 1910*a*" by C. Michie Smith. (Astronomische Nachrichten No. 4392).

"Radial Movement in Sunspots" (second paper) By J. Evershed (M.N., R.A.S., LXX).

"Halley's comet and its Spectrum" (M.N., R.A.S., LXX.).

"Transit of Halley's comet" (M.N., R.A.S., LXX.).

"Observations of the Tail of Halley's comet before and after the day of transit" by J. Evershed (M.N., R.A.S., LXX).

22. **General.**—The Director-General of Observatories inspected the Madras and Kodaikánal Observatories in January. The Director inspected the Madras Observatory in November and rewired the transit instrument.

The staff of the observatory has worked well throughout the year. The First Assistant Mr. S. Sitarama Aiyar has shown his usual ability and zeal, and in the photographic work Mr. R. Krishna Aiyar has rendered most efficient service.

THE OBSERVATORY, KODAIKÁNAL,
*7th February* 1911.

J. EVERSHED,
*Director, Kodaikánal and Madras Observatories.*

## II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1910.

**Staff.**—I handed over charge of the Observatory on the afternoon of the 28th April to Professor E. B. Ross of the Madras Christian College and resumed charge again from him on July 9th. The first assistant was on privilege leave for one month and 13 days and the second assistant for two months.

2. **Time Service.**—Astronomical observations for determination of time were carried on as in previous years. No change was made in the signals distributed from the Observatory. The fort gun failed on 5 occasions and in addition to these on every evening at 8 P.M. between the 6th March and 13th April. It was fired correctly on 686 occasions out of a maximum of 730 : this gives a precentage of 94 of successes. The evening gun failed between the 6th March and 13th April because the Adjutant-General had issued orders to the Military authorities that it was to be abolished from March 6th. As I had received no orders from the Director of the Observatory to discontinue these signals, I had to enter them as failures. Orders to resume the firing of the gun at 8 P.M. were issued subsequently. and came into effect on 14th April. Leaving out these failures the percentage of successes was 99·3. The time ball at the Port Office was dropped correctly at 1 P.M. on every day except 10 and on 9 out of these 10 it was dropped at 2 P.M.

3. **Meteorological observations.**—In addition to the ordinary meteorological observations, extra observations and telegrams were taken and sent to Simla on 4 occasions and on 99 occasions to Calcutta. The tabulation of the traces of the autographic instruments are up to date.

4. **Buildings.**—Certain repairs to the quarters of the Deputy Director were effected during the year. The Observatory building and the dome over the Equatorial were painted.

5. **Instruments.**—The following is a list of the instruments at the Madras Observatory on the 31st December 1910 :—

(*a*) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton & Simms.
Sidereal Clock—Haswall.
" Dent, No. 1408.
" S. Reifler, No. 61.
Mean Time Clock with galvanometer—Shepherd & Sons.
Meridian Circle—Troughton & Simms.
Mean Time Clock—J. Monk.
Mean Time Chronometer—V. Kullberg, No. 5394.
" " No. 6544.
" Parkinson and Frodsham, No. 2352.
Portable Transit Instrument—Dolland.
Portable Telescope with stand.
Tape Chronograph—R. Fuess.
Relay for use with the Chronograph—Siemens.

(*b*) *Meteorological.*

Richard's Barograph—No. 10, L. Casella.
" Thermograph—No. 3618, L. Casella.
Beckley's Anemograph—Adie.
Sunshine Recorder—No. 149, L. Casella.
Anemoscope—P. Orr & Sons.
Nephoscope—Mons Jules Daboscq & Ph. Pellin.
Barometer, Fortin's—No. 1771, L. Casella.
" No. 725, L. Casella (spare).
" No. 1420, L. Casella (spare).
Dry Bulb Thermometer—No. 94221, L. Casella.
" No. 38037, Negretti & Zambra (spare).
Wet Bulb Thermometer—No. 94219, L. Casella.
" No. 38037, Negretti & Zambra (spare).
Dry Maximum Thermometer—No. 8581, Negretti & Zambra.
Dry Minimum Thermometer—No. 69047, L. Casella.
Wet Minimum Thermometer—No. 91753, Negretti & Zambra.
Sun Maximum Thermometer—No. 10479, Negretti & Zambra.
Grass Minimum Thermometer—No. 3377, Negretti & Zambra.

Raingauge (8″ diameter)—No. 1042, Negretti & Zambra.
Measure glass for above.
Raingauge (5″ diameter).
Measure glass for above.

The wires of the Transit Instrument had to be renewed in May 1910. In November the Director inspected the Observatory and brought the dividing engine from Kodaikánal; the carrier was redivided, and new wires were put in. These are much more satisfactory than the old ones. The Transit Instrument has undergone a very large change in level. This change commenced in December 1909 and went steadily on in the same direction till the heavy rain in September, when it stopped and began to go back again. There has been very little change in azimuth; but the level error had to be cleared on two occasions.

The rate of the Riefler clock has been on the whole very satisfactory; the Dent clock too has had a fairly steady rate. They were both adjusted to a small losing rate during the inspection of the Director.

The recording apparatus of the Beckley's Anemograph was overhauled and partly repaired during the year.

6. **Weather summary.**—The following is a summary of the meteorological conditions at Madras during the year 1910:—

*Pressure.*—Pressure was below normal in all months except May and December. The greatest excess was 0·025 inch in December and the greatest defect 0·059 inch in September. The highest pressure recorded was 30·129 inches on December 26 and the lowest 29·516 inches on June 24.

*Temperature.*—The mean temperature was above normal in all months except July, August, November, and December. The maximum temperature was below normal from June to September and in November, the greatest excess being 2°·9F. in May and the greatest defect 2°·5F. in August. The minimum was normal in September, below normal in January, March, July, November, and December and above in the remaining months. The minimum on grass was above normal in all months except March, July, November, and December. The highest shade temperature was 112°·9F. on May 20 and the lowest 62°·3F. on December 18.

*Humidity.*—The percentage of humidity was normal in February, below normal in May and December and above normal during the rest of the year.

*Wind.*—Wind direction was normal in February, June, and December and it differed most from normal in October when it was 7 points more southerly than usual, the average direction being east by north. The air movement recorded was lower than the average throughout the year.

*Cloud.*—The percentage of cloud was normal in September, above normal in June and below in the remaining months.

*Sunshine.*—The percentage of bright sunshine was below normal in all months except April, July, and December, the greatest defect being in June. The total number of hours of bright sunshine during the year was 2,243·9.

*Rainfall.*—The rainfall was above the average in July, August, and November and below during the other months, the greatest excess being 4·21 inches in July and the greatest defect 5·23 inches in December. The rainfall for the year was 44·47 inches on 85 days, being 4·55 inches below the average. The monsoon rainfall from October 15 to the end of the year was 25·47 inches against an average of 26·00 inches. The heaviest fall on any civil day was 5·47 inches on November 5.

*Storm.*—A storm formed in the south-west of the Bay on July 22 and moved in a northerly direction towards Gopalpore, when Madras received $4\frac{1}{4}$ inches. Another storm formed between Port Blair aud Negapatam on November 2 and moved on a north-westerly course and crossed the coast near Nellore on the 6th. It gave very heavy rain at and around Madras, a little over 7 inches being recorded at Madras between 8 A.M. on the 5th and 8 A.M. on the 6th.

MADRAS OBSERVATORY,
*5th January* 1911.

R. LL. JONES,
*Deputy Director.*

# EXPLANATION OF TABLES.

## (1) Appendices II. to VI. (Kodaikánal).

*Barometer.*—The readings are reduced to 32° F. but are not corrected to latitude 45°. As the value of $g$ at Kodaikánal is 977·643 this correction would be—0·067 at 22 inches and—0·070 at 23 inches.

The daily mean is obtained from the readings of the Richard Barograph corrected to the three daily readings of the standard barometer.

*Thermometers.*—The daily mean temperatures of the wet and dry bulbs are obtained from the hourly readings of the Richard hygrometer corrected by reference to the readings of the standard wet and dry bulb thermometers.

*Wind.*—The mean direction given is the arithmetical mean of the hourly directions corrected by the addition or subtraction of a multiple of 32 points.

The Beckley anemograph is carried on a small tower well separated from the other buildings. The height of the cups above the top of the hill is 40 feet. So far no corrections have been applied to the readings.

*Rain.*—A " day of rain " is one on which 0·10 inch and upwards falls.

*Clear sky* is estimated at 8 A.M., 10 A.M., and 4 P.M. and the mean is taken.

The averages referred to are those given in appendix VI. to the present report.

## (2) Appendices VII. to XIII. (Madras).

The methods employed and the averages used are given in full in " Results of the Meteorological Observations made at the Government Observatory, Madras, during the years 1861—1890 " and in " Madras Observatory Daily Meteorological Means."

The Barometer readings are not reduced to sea level or to gravity at latitude 45°. The corrections to be applied to reduce the readings to sea level and gravity at latitude 45° are as follows:—

| Barometer. | Temperature. | | |
|---|---|---|---|
| Inches. | 70° | 80° | 90° |
| 29 .. | — 0·044 | — 0·044 | — 0·045 |
| 30 .. .. | ·046 | ·046 | ·047 |
| 31 .. .. | ·048 | ·048 | ·049 |

*Wind.*—The cups of the Beckley anemograph are 44 feet above the ground and 18 feet above the parapet of the flat-roofed building. The readings are uncorrected.

*Rain.*—A day of rain is one on which 0·01 inch and upwards falls.

# Appendix I.

## Kodaikánal Observatory Seismological Records in 1910.

| No. | Date | | P.T. commence G.M.T. | L. W. commence G.M.T. | Maxima G.M.T. | End. | Max. Amp. | Duration | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | 1910. | | H. M. | H. M. | H. M. | H. M. | MM. " | H. M. | |
| 1 | Jan. | 1 .. | 11 22·3 | 12 28·7 | 12 46·5 | 14 06 | 0·4 = 0·2 | 2 44 | |
| 2 | | 8 .. | 14 59·9? | 15 21·5 | 15 23·0 | 15 59 | 0·4 = 0·2 | 0 59 | |
| 3 | | 14 .. | 8 40·3 | 8 52·8 | 8 53·8 | 9 14 | 0·4 = 0·2 | 0 34 | |
| 4 | | 15 .. | 22 34·1 | .. | .. | 23 10 | .. | 0 36 | Widening of line. |
| 5 | | 22 .. | 8 54·7 | 9 33·6 | 9 36·2 | .. | 0·9 = 0·5 | .. | |
| | | | | | 43·4 | 11 27 | 1·0 = 0·5 | 2 32 | |
| 6 | | 23 .. | 19 36·2 | 20 08·1 | 20 11·2 | 21 09 | 0·3 = 0·2 | 1 32 | |
| 7 | | 30 .. | 4 09·6 | 4 40·3 | 4 43·4 | 5 25 | 0·6 = 0·3 | 1 15 | Sheet marked 4h 47m. |
| 8 | Feb. | 4 .. | 14 24·4 | 14 52·6 | .. | 16 50 | 0·5 = 0·2 | 2 26 | Many small maxima. |
| 9 | | 4 .. | 18 00·8 | .. | .. | 20 28 | .. | 2 27 | Widening of line. |
| 10 | | 12 .. | 18 18·2 | 18 53·3 | 18 53·3 | 19 51 | 0·6 = 0·3 | 1 33 | |
| 11 | | 28 .. | 21 55·6 | 22 04·3 | 22 06·3 | 22 39 | 0·6 = 0·3 | 0 43 | |
| 12 | March | 30 .. | 17 16·4 | 18 07·1 | 18 10·7 | 20 13 | 2·0 = 1·0 | 2 57 | |
| 13 | | 31 .. | 18 52·8 | 19 32·5 | 19 35·6 | 20 43 | 0·7 = 0·4 | 1 51 | |
| 14 | April | 1 . | 14 06·2 | .. | .. | 14 56 | .. | 0 50 | Widening of line. |
| 15 | | 12 .. | 0 22·8 | 0 30·5 | 0 38·3 | 2 20 | 2·0 = 1·0 | 1 57 | |
| 16 | | 16 .. | 12 37·2 | 13 05·2 | 13 06·1 | 13 36 | 0·5 = 0·3 | 0 59 | |
| 17 | | 17 .. | 1 38·6 | 1 50·3 | 1 55·4 | 2 45 | 0·4 = 0·2 | 1 06 | |
| 18 | | 27 .. | 2 50·3 | 2 55·9 | 3 02·5 | 3 29 | 0·6 = 0·3 | 0 39 | |
| 19 | May | 1 .. | 18 54·6 | 19 38·2 | 19 43·3 | 20 51 | 2·1 = 1·1 | 1 56 | |
| 20 | | 10 .. | 18 43·2 | 19 01·8 | 19 03·9? | 19 26 | 0·5 = 0·2 | 0 43 | |
| 21 | | 11 .. | 15 59·7 | .. | .. | 16 16 | .. | 0 16 | Widening of line. |
| 22 | | 13 .. | 8 21·7 | 9 02·6 | 9 06·2 | 10 53 | 0·6 = 0·3 | 2 31 | |
| 23 | | 15 .. | 16 17·1 | 16 36·7 | 16 39·3 | 17 10 | 0·5 = 0·2 | 0 53 | |
| 24 | | 18 .. | 16 15·6 | 16 22·3 | 16 34·6 | 17 18 | 1·1 = 0·5 | 1 02 | |
| 25 | | 20 .. | 13 40·6 | .. | .. | 13 59 | .. | 0 18 | Widening of line. |
| 26 | | 22 .. | 6 36·1 | 7 08·4 | 7 12·5 | 8 15 | 1·2 = 0·5 | 1 39 | |
| 27 | June | 1 .. | 6 17.2 | .. | .. | 7 23 | .. | 1 06 | Widening of line. |
| 28 | | 16 .. | 6 44·4 | 6 54·6 | 6 55·9 | 10 20 | 4·0 = 2·2 | 3 36 | |
| 29 | | 17 .. | 5 36·2 | 5 55·9 | 5 59·0 | 6 11 | .. | 0 35 | Widening of line. |
| 30 | | 19 .. | 15 11·0 | .. | .. | 16 53 | .. | 1 42 | Widening of line. |
| 31 | | 24 .. | 3 36·7 | 4 00·8 | 4 01·8 | 4 22 | .. | 0 45 | Widening of line. |
| 32 | | 24 .. | 13 40·3 | 14 09·0 | 14 12·0 | 15 24 | 0·4 = 0·3 | 1 44 | |
| 33 | | 29 .. | 9 17·2 | .. | .. | 9 41 | .. | 0 24 | Widening of line. |
| 34 | | 29 .. | 11 20·6 | 11 50·5 | 11 52·5 | 13 34 | 1·1 = 0·6 | 2 13 | |
| 35 | | 29 .. | 14 42·8 | 15 26·4 | 15 28·7 | 16 52 | 1·2 = 0·7 | 2 09 | |
| 36 | July | 7 .. | 8 24·4 | 8 44·4 | 8 46·4 | 9 57 | 2·5 = 1·4 | 1 33 | |
| 37 | | 12 .. | 7 46·4 | .. | .. | 8 00 | .. | 0 14 | Widening of line (Kashmir). |
| 38 | | 15 .. | 13 10·8 | .. | 13 17·2 | 13 27 | .. | 0 16 | Widening of line. |
| 39 | | 21 .. | 22 10·5 | .. | .. | 22 55 | .. | 0 45 | Widening of line. |
| 40 | | 24 .. | 16 16·4 | 16 23·4 | 16 29·5 | 16 50 | .. | 0 34 | Widening of line. |
| 41 | | 29 .. | 10 46·4 | 11 17·2 | 11 22·3 | 12 40 | 1·1 = 0·5 | 1 54 | |
| 42 | Aug. | 13 .. | 8 06·4 | .. | 8 08·0 | 8 22 | .. | 0 16 | Widening of line. |
| 43 | | 16 .. | 7 48·5 | .. | .. | 8 16 | .. | 0 28 | Widening of line. |
| 44 | | 17 .. | 11 54·5 | 12 12·9 | 12 14·4 | 13 16 | 4·0 = 1·9 | 1 22 | |
| 45 | | 17 .. | 23 33·6 | .. | 23 36·1 | 24 00 | .. | 0 26 | Widening of line. |
| 46 | | 21 .. | 5 47·4 | 6 01·8 | 6 06·9 | 7 56 | 0·6 = 0·3 | 2 09 | |
| 47 | Sept. | 1 .. | 0 52·6 | 1 11·0 | 1 16·6 | 2 12 | 3·5 = 1·7 | 1 19 | |
| 48 | | 1 .. | 14 33·1 | 14 48·5 | 14 52·6 | 15 26 | 0·8 = 0·4 | 0 53 | |
| 49 | | 6 .. | 20 26·4 | 21 21·6 | 21 30·0 | 22 08 | 1·0 = 0·5 | 1 42 | |
| 50 | | 7 .. | 6 35·2 | 7 33·1 | 8 05·6 | 9 38 | 0·6 = 0·3 | 3 03 | |
| 51 | | 9 .. | 1 25·9 | 2 05·5 | 2 18·4 | 4 13 | 0·6 = 0·3 | 2 47 | Many small maxima. |
| 52 | | 9 .. | 9 36·2 | .. | .. | 11 25 | .. | 1 49 | Widening of line. |
| 53 | | 10 .. | 12 38·6 | .. | 12 50·0 | 13 26 | .. | 0 47 | Widening of line. |
| 54 | | 12 .. | 16 42·7 | .. | .. | 16 52 | .. | 0 09 | Widening of line. |
| 55 | | 14 .. | 14 09·0 | 14 50·3 | 14 52·3 | 15 09 | 0·4 = 0·2 | 1 00 | |
| 56 | | 16 .. | 23 16·8 | .. | .. | 23 58 | .. | 0 41 | Widening of line. |
| 57 | Oct. | 4-5 .. | 23 12·6 | .. | .. | 0 54 | .. | 1 41 | Widening of line. |
| 58 | | 7 .. | 12 54·6 | .. | .. | 13 12 | .. | 0 17 | Widening of line. |
| 59 | | 7 .. | 16 04·7 | 16 10·0 | 16 11·6 | 16 25 | 0·4 = 0·2 | 0 20 | |
| 60 | | 18 .. | 3 02·8 | 3 39·2 | 3 40·3 | 4 06 | 0·6 = 0·2 | 1 03 | |
| 61 | | 20 .. | 5 02·8 | 5 15·6 | 5 17·2 | 5 55 | 1·7 = 0·6 | 0 52 | |
| 62 | Nov. | 9 .. | * 6 10·5 | 6 58·7 | 7 06·0 | .. | 7·5 = 3·8 | .. | * Possibly not till 6h 15m1. |
| | | | | | 7 11·0 | 9 36 | 7·0 = 3·6 | 3 26 | |
| 63 | | 14 .. | 7 44·4 | 8 02·8 | 8 06·0 | 9 13 | 0·5 = 0·3 | 1 29 | |
| 64 | | 15 .. | 14 46·4 | 15 26·4 | 15 27·4 | 16 21 | 0·7 = 0·4 | 1 35 | |
| 65 | | 24 .. | .. | 15 48·9 | 15 50·4 | 16 14 | 0·6 = 0·3 | 0 25 | |
| 66 | | 25 .. | 20 57·7 | 21 04·3 | 21 06·9 | 21 19 | .. | 0 21 | Widening of line. |
| 67 | | 26 .. | 5 53·6 | 6 38·7 | 6 41·2 | .. | 5·0 = 2·4 | .. | |
| | | | | | 6 43·8 | 9 37 | 5·0 = 2·4 | 3 43 | |

## Kodaikánal Observatory Seismological Records in 1910—*cont.*

| No. | Date. | | P.T. commence G.M.T. | | L.W. commence G.M.T. | | Maxima G.M.T. | | End. | | Max. Amp. | Duration. | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1910. | | H. | M. | H. | M. | H. | M. | H. | M. | MM. " | H. | M. | |
| 68 | Nov. | 29 .. | 2 | 41·6 | 2 | 53·6 | 2 | 55·4 | 3 | 31 | 1·6 = 0·8 | 0 | 49 | |
| 69 | Dec. | 1 .. | 15 | 57·8 | 16 | 14·3 | 16 | 15·3 | 17 | 05 | 2·5 = 1·2 | 1 | 07 | |
| 70 | | 3 .. | 8 | 33·6 | .. | | 8 | 52·6 | 9 | 18 | .. | 0 | 44 | Widening of line. |
| 71 | | 4 .. | 11 | 27·9 | 11 | 55·1 | 11 | 58·8 | 12 | 29 | 1·1 = 0·5 | 1 | 01 | |
| 72 | | 10 .. | 9 | 42·3 | 10 | 21·3 | 10 | 32·6 | 12 | 18 | 2·0 = 0·9 | 2 | 36 | |
| 73 | | 13 .. | 11 | 42·7 | 11 | 57·8 | 12 | 06·5 | 15 | 13 | 15·2 = 7·2 | 3 | 30 | |
| 74 | | 16 .. | 14 | 50·6 | 15 | 00·9 | 15 | 19·4 | 18 | 41 | 15 = 7·1 | 3 | 50 | |
| 75 | | 16 .. | 19 | 01·0 | 19 | 25·6 | 19 | 27·7 | 20 | 01 | 1·6 = 0·8 | 1 | 00 | |
| 76 | | 18 .. | 2 | 52·6 | 3 | 04·0 | 3 | 04·9 | 4 | 06 | 0·6 = 0·3 | 1 | 13 | |
| 77 | | 18 .. | 5 | 38·2 | .. | | 5 | 42·8 | 5 | 53 | 0·4 = 0·2 | 0 | 15 | |
| 78 | | 18 .. | 19 | 23·4 | .. | | .. | | 19 | 48 | .. | 0 | 25 | Widening of line. |
| 79 | | 23 .. | 1 | 04·9 | 1 | 06·9 | 1 | 08·9 | 1 | 45 | 0·8 = 0·4 | 0 | 40 | |
| 80 | | 29 .. | 13 | 12·5 | 13 | 37·6 | 13 | 38·6 | 14 | 15 | 0·4 = 0·2 | 1 | 02 | |
| 81 | | 30 .. | 0 | 55·8 | 1 | 07·6 | 1 | 09·1 | 1 | 56 | 1·0 = 0·5 | 1 | 00 | |

# Appendix II.

Latitude 10° 13′ 50″ N.
Longitude 5h 09m 52s E.

Height of barometer cistern above mean sea level, 7,688 feet.

MEAN monthly and annual Meteorological Results at the Kodaikánal Observatory in 1910.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer. Mean. | Dry bulb thermometer. Max. | Dry bulb thermometer. Min. | Dry bulb thermometer. Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. By Blanford's tables. | Relative humidity. By Blanford's tables. | Sun Max. *in vac.* | Min. on grass. | Wind. Daily velocity. | Wind. Mean direction. | Wind. Mean direction. | Rain. Amount. | Rain. Days. | Clear sky. | Hours of bright sun-shine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | POINTS. | POINTS. | INCHES. | NO. | CENTS. | |
| January .. .. | 22·809 | 0·073 | 53·2 | 62·9 | 46·3 | 16·6 | 45·3 | 38·2 | 0·227 | 56 | 112·0 | 34·9 | 316 | 5 | N.E. by E. | 1·77 | 4 | 65 | 247 6 |
| February .. | ·812 | ·068 | 53·9 | 63·6 | 47·0 | 16·6 | 46·4 | 40·7 | ·248 | 59 | 117·9 | 38·0 | 320 | 2 | N.N.E. | 1·30 | 4 | 66 | 230·7 |
| March .. .. | ·830 | ·063 | 58·0 | 68·6 | 50·8 | 17·8 | 47·7 | 41·4 | ·232 | 48 | 125·2 | 39·9 | 328 | 7 | E. by N. | 0·01 | .. | 85 | 279·8 |
| April .. | ·821 | ·066 | 60·4 | 69·5 | 54·6 | 14·9 | 51·5 | 45·9 | ·296 | 57 | 127·5 | 46·1 | 353 | 8 | E. | 4·10 | 5 | 62 | 232·9 |
| May .. .. | ·827 | ·068 | 60·4 | 69·0 | 54·9 | 14·1 | 54·8 | 50·4 | ·375 | 72 | 127·6 | 46·4 | 225 | 5 | N.E. by E. | 6·29 | 13 | 52 | 203·9 |
| June .. .. | ·743 | ·060 | 57·2 | 63·2 | 53·6 | 9·6 | 54·2 | 50·5 | ·391 | 83 | 113·1 | 49·1 | 358 | 25 | W. by N. | 8·57 | 14 | 23 | 104·0 |
| July .. .. | ·749 | ·058 | 55·9 | 62·2 | 52·2 | 10·0 | 53·7 | 50·3 | 394 | 88 | 115·9 | 48·0 | 353 | 31 | N. by W. | 10·94 | 21 | 22 | 110·9 |
| August .. .. | ·749 | ·064 | 55·8 | 61·8 | 52·6 | 9·2 | 54·2 | 50·8 | 405 | 90 | 118·3 | 50·7 | 332 | 26 | W.N.W. | 10·23 | 21 | 21 | 95·0 |
| September .. | ·743 | ·067 | 55·6 | 62·0 | 51·6 | 10·4 | 53·1 | 48·9 | ·382 | 86 | 117·5 | 48·1 | 390 | 26 | W.N.W. | 4·32 | 8 | 28 | 137·4 |
| October .. | ·793 | ·077 | 55·8 | 62·3 | 51·7 | 10·6 | 54·4 | 49·9 | ·411 | 92 | 117·7 | 46·9 | 232 | 24 | W. | 12·86 | 19 | 23 | 89·2 |
| November .. | ·803 | ·069 | 54·4 | 61·1 | 49·9 | 11·2 | 51·2 | 46·1 | ·350 | 83 | 110·1 | 44·8 | 233 | 0 | N. | 11·41 | 13 | 36 | 118·3 |
| December .. | ·839 | ·066 | 56·2 | 67·6 | 48·2 | 19·4 | 44·7 | 36·9 | ·178 | 39 | 116·1 | 38·0 | 331 | 8 | E. | .. | .. | 84 | 267·4 |
| Annual .. | 22·793 | 0·067 | 56·4 | 64·5 | 51·1 | 13·4 | 50·9 | 45·8 | 0·324 | 71 | 118·2 | 44·2 | 314 | 1 | N. by E. | 71·80 | 122 | 47 | 2,117·1 |

EXTREME monthly Meteorological Records at the Kodaikánal Observatory in 1910.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry bulb thermometer. Highest. | | Dry bulb thermometer. Lowest. | | Wet bulb. Lowest. | | Humidity. Lowest. | | Sun Th. *in vacuo.* Highest. | | Grass therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest fall | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES | DAY. | INCHES | DAY. |
| January .. .. | 22·902 | 29 | 22·704 | 8 | 0·198 | 68·9 | 21 | 42·9 | 22 | 33·4 | 25 | 7 | 24 | 122·7 | 26 | 23·9 | 10 | 494 | 6 | 157 | 9 | 1·02 | 30 |
| February .. | ·920 | 4 | ·730 | 18 | ·190 | 67·5 | 13 | 40·8 | 8 | 32·0 | 6 | 4 | 9 | 131·4 | 16 | 23·2 | 12 | 635 | 2 | 174 | 13 | 0·77 | 19 |
| March .. .. | ·913 | 14 | ·767 | 2 | ·146 | 74·1 | 20 | 46·9 | 15 | 35·6 | 18 | 11 | 18 | 136·7 | 29 | 33·1 | 17 | 480 | 14 | 129 | 6 | 0 01 | 13 |
| April .. .. | ·902 | 26 | ·742 | 11 | ·160 | 75·4 | 1 | 52·2 | 6 | 38·4 | 6 | 8 | 6 | 135·6 | 16 | 40·9 | 25,26 | 623 | 7 | 187 | 16 | 1·09 | 28 |
| May .. .. | ·890 | 5 | ·735 | 31 | 155 | 74·1 | 28 | 51·9 | 21 | 46·9 | 2 | 42 | 16 | 135·6 | 5 | 41 1 | 26 | 344 | 19 | 97 | 23 | 1·07 | 13 |
| June .. .. | ·842 | 2 | ·614 | 24 | ·228 | 70·2 | 3 | 51·1 | 30 | 48·0 | 10 | 54 | 8 | 140·5 | 3 | 42·2 | 3 | 641 | 25 | 119 | 13 | 1·41 | 6 |
| July .. .. | ·842 | 12, 13 | ·648 | 24 | ·194 | 68·2 | 13 | 48 1 | 11 | 46·4 | 11 | 58 | 19 | 136·3 | 12 | 41·8 | 17 | 800 | 3 | 104 | 20 | 1·22 | 25 |
| August .. .. | ·833 | 10 | ·672 | 20 | ·161 | 65·4 | 12 | 51·1 | 2 | 46·3 | 12 | 61 | 11 | 133·4 | 23 | 41·1 | 13 | 552 | 7 | 152 | 13 | 2·62 | 22 |
| September .. | ·823 | 19 | ·667 | 28 | ·156 | 65·6 | 16 | 48·7 | 6 | 44·2 | 16 | 47 | 15 | 136·9 | 16 | 41·3 | 16 | 626 | 5 | 195 | 1 | 1·37 | 2 |
| October .. .. | ·877 | 9 | ·719 | 28 | ·158 | 66·0 | 11 | 48·0 | 6 | 43·2 | 6 | 53 | 3 | 134·6 | 6 | 34·6 | 6 | 419 | 18 | 124 | 10 | 2·07 | 10 |
| November .. | .903 | 14 | ·659 | 6 | ·244 | 70·3 | 29 | 44·6 | 19 | 32·4 | 29 | 7 | 29 | 137·5 | 14 | 33·1 | 29 | 641 | 7 | 96 | 14 | 3·62 | 16 |
| December .. | ·923 | 26 | ·762 | 8 | ·161 | 73·7 | 19 | 40·8 | 17 | 32·1 | 3,15 | 5 | 3 | 122·2 | 5 | 16·3 | 17 | 465 | 7 | 214 | 19 | .. | .. |

# Appendix III.

KODAIKÁNAL mean hourly wind velocity for the year 1910.

| Month. | Hours. | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| January .. | 15 | 15 | 14 | 15 | 14 | 14 | 15 | 15 | 14 | 15 | 16 | 15 | 14 | 15 | 12 | 10 | 8 | 8 | 9 | 12 | 13 | 13 | 14 | 15 |
| February .. | 14 | 13 | 15 | 15 | 15 | 16 | 16 | 16 | 16 | 16 | 16 | 15 | 15 | 13 | 12 | 11 | 10 | 9 | 9 | 10 | 10 | 11 | 12 | 13 |
| March .. | 13 | 13 | 13 | 13 | 13 | 14 | 15 | 16 | 18 | 19 | 20 | 19 | 18 | 15 | 13 | 11 | 10 | 9 | 9 | 10 | 10 | 11 | 12 | 14 |
| April .. | 14 | 14 | 14 | 13 | 13 | 13 | 13 | 15 | 18 | 17 | 15 | 17 | 16 | 14 | 15 | 14 | 13 | 12 | 13 | 14 | 13 | 14 | 15 | 15 |
| May .. | 10 | 10 | 9 | 9 | 8 | 8 | 9 | 9 | 10 | 11 | 11 | 11 | 10 | 10 | 11 | 10 | 8 | 8 | 9 | 8 | 8 | 8 | 9 | 11 |
| June .. | 15 | 16 | 17 | 17 | 18 | 16 | 15 | 14 | 16 | 14 | 15 | 15 | 14 | 13 | 13 | 14 | 14 | 14 | 16 | 15 | 15 | 14 | 15 | 15 |
| July .. | 15 | 16 | 15 | 14 | 15 | 15 | 15 | 14 | 15 | 14 | 15 | 14 | 14 | 14 | 15 | 14 | 14 | 14 | 15 | 14 | 14 | 15 | 16 | 16 |
| August .. | 15 | 15 | 15 | 16 | 17 | 16 | 16 | 15 | 14 | 13 | 13 | 13 | 12 | 12 | 12 | 12 | 12 | 14 | 13 | 13 | 12 | 13 | 13 | 14 |
| September .. | 19 | 20 | 20 | 20 | 20 | 20 | 20 | 18 | 17 | 14 | 14 | 15 | 14 | 13 | 13 | 13 | 13 | 13 | 14 | 15 | 16 | 17 | 19 | 20 |
| October .. | 11 | 10 | 10 | 10 | 9 | 9 | 9 | 9 | 10 | 11 | 10 | 9 | 11 | 10 | 10 | 10 | 9 | 9 | 11 | 9 | 9 | 9 | 10 | 10 |
| November .. | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 9 | 11 | 10 | 10 | 9 | 9 | 9 | 8 | 8 | 9 | 9 | 10 | 10 | 11 | 10 |
| December .. | 15 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | 16 | 15 | 13 | 12 | 10 | 8 | 10 | 12 | 12 | 12 | 14 | 15 | 16 |
| Annual .. | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 13 | 12 | 12 | 11 | 11 | 12 | 12 | 12 | 12 | 13 | 14 |

## Appendix IV.

KODAIKÁNAL Mean Hourly Bright Sunshine for the year 1910.

| Month. | Hours. | | | | | | | | | | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6–7 | 7–8 | 8–9 | 9–10 | 10–11 | 11–12 | 12–13 | 13–14 | 14–15 | 15–16 | 16–17 | 17–18 | |
| January .. .. | 0·11 | 0·61 | 0·83 | 0·87 | 0·85 | 0·87 | 0·85 | 0·78 | 0·75 | 0·75 | 0·62 | 0·11 | |
| February .. .. | ·13 | ·68 | ·85 | ·85 | ·86 | ·88 | ·84 | ·78 | ·78 | ·73 | ·66 | ·23 | |
| March .. .. | ·05 | ·87 | 1·00 | ·99 | ·95 | ·91 | ·85 | ·82 | ·77 | ·78 | ·74 | ·29 | |
| April .. .. .. | ·16 | ·82 | ·90 | ·90 | ·91 | ·81 | ·76 | ·76 | ·61 | ·53 | ·45 | ·14 | |
| May .. .. .. | ·39 | ·85 | ·91 | ·95 | ·86 | ·80 | ·61 | ·44 | ·36 | ·23 | ·14 | ·03 | |
| June .. .. .. | ·09 | ·33 | ·52 | ·55 | ·52 | ·47 | ·35 | ·22 | ·13 | ·14 | ·09 | ·05 | |
| July .. .. .. | ·19 | ·43 | ·55 | ·54 | ·49 | ·45 | ·33 | ·24 | ·14 | ·12 | ·08 | ·02 | |
| August .. .. | ·06 | ·28 | ·44 | ·56 | ·50 | ·35 | ·28 | ·25 | ·14 | ·12 | ·05 | ·02 | |
| September .. .. | ·02 | ·46 | ·71 | ·69 | ·60 | ·57 | ·48 | ·37 | ·22 | ·21 | ·18 | ·07 | |
| October .. .. | ·00 | ·29 | ·53 | ·55 | ·49 | ·34 | ·24 | ·14 | ·16 | ·06 | ·06 | ·01 | |
| November .. .. | ·00 | ·13 | ·45 | ·54 | ·51 | ·52 | ·45 | ·34 | ·36 | ·33 | ·27 | ·03 | |
| December .. .. | ·04 | ·54 | ·78 | ·95 | ·94 | ·94 | ·93 | ·91 | ·90 | ·84 | ·76 | ·09 | |
| Mean .. | 0·10 | 0·52 | 0·71 | 0·74 | 0·71 | 0·66 | 0·58 | 0·50 | 0·44 | 0·40 | 0·34 | 0·09 | |

## Appendix V.

NUMBER of days in each month on which the Nilgiris were visible during 1910.

| Month. | Very clear. | Visible. | Just visible. | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January .. .. .. .. | 7 | 6 | 5 | 1 | 19 |
| February .. .. .. .. | 3 | 4 | 3 | .. | 10 |
| March .. .. .. .. | 1 | 1 | .. | 2 | 4 |
| April .. .. .. .. | .. | 1 | .. | 1 | 2 |
| May .. .. .. .. .. | 3 | 5 | 4 | .. | 12 |
| June .. .. .. .. .. | 7 | 6 | .. | 1 | 14 |
| July .. .. .. .. .. | 5 | 2 | .. | .. | 7 |
| August .. .. .. .. | 6 | 3 | .. | .. | 9 |
| September .. .. .. .. | 7 | 9 | 3 | 1 | 20 |
| October .. .. .. .. | 6 | 8 | 1 | .. | 15 |
| November .. .. .. .. | 4 | 10 | .. | 1 | 15 |
| December .. .. .. .. | 2 | 18 | 1 | 8 | 29 |
| Total .. | 51 | 73 | 17 | 15 | 156 |

# Appendix VI.

## Meteorological Means. Kodaikánal.

| — | Barometer. | | Dry Bulb. | | | | Wet Bulb. | | Vapour Tension. | Humidity. | Sun maximum. | Grass minimum. | Wind. | | Rain. | | Clear sky Cents. | Bright sunshine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reduced to 32° | Range. | Mean. | Maximum. | Minimum. | Range. | Mean. | Minimum. | | | | | Velocity. | Direction. | | | | |
| | inches. | inch. | ° | ° | ° | ° | ° | ° | inch. | cents. | ° | ° | miles. | points. | inches. | days. | | hours. |
| January .. | 22·845 | 0·071 | 53·4 | 63·0 | 47·0 | 15·9 | 47·0 | 40·6 | 0·263 | 64 | 117·4 | 37·8 | 309 | 4 | 3·22 | 4·0 | 64 | 229·7 |
| February .. | ·853 | ·070 | 55·0 | 65·6 | 48·0 | 17·6 | 48·0 | 41·5 | ·267 | 61 | 124·7 | 38·4 | .287 | 1 | 1·74 | 2·5 | 64 | 222·5 |
| March .. | ·856 | ·069 | 57·8 | 68·7 | 50·8 | 17·8 | 49·1 | 42·5 | ·265 | 55 | 130·3 | 41·2 | 310 | 6 | 2·14 | 3·4 | 70 | 252·6 |
| April .. .. | ·833 | ·070 | 59·7 | 69·3 | 53·7 | 15·6 | 53·3 | 47·4 | ·346 | 68 | 133·3 | 45·4 | 278 | 6 | 4·28 | 7·6 | 54 | 211·4 |
| May .. .. | ·816 | ·069 | 60·3 | 68·8 | 54·8 | 14·0 | 55·0 | 50·2 | ·382 | 73 | 132·6 | 48·4 | 253 | 2 | 5·48 | 11·8 | 46 | 200·5 |
| June .. .. | ·768 | ·059 | 57·9 | 65·1 | 53·6 | 11·4 | 53·9 | 49·8 | ·377 | 78 | 126·8 | 48·9 | 373 | 25 | 3·22 | 10·5 | 28 | 119·8 |
| July .. .. | ·755 | ·057 | 56·3 | 62·9 | 52·5 | 10·3 | 53·3 | 49·6 | ·379 | 84 | 122·0 | 48·7 | 427 | 26 | 4·19 | 11·8 | 23 | 102·6 |
| August .. | ·771 | ·065 | 56·5 | 63·2 | 52·5 | 10·8 | 53 8 | 49·8 | ·390 | 85 | 124·0 | 48·3 | 318 | 26 | 7·24 | 13·2 | 27 | 114·3 |
| September .. | ·788 | ·072 | 56·4 | 63·3 | 52·2 | 11·1 | 53·5 | 49·4 | ·385 | 84 | 125·6 | 48·0 | 297 | 27 | 6·72 | 13·3 | 32 | 120·5 |
| October .. | ·809 | ·077 | 55·5 | 62·3 | 51·3 | 11·0 | 53·0 | 49·2 | ·381 | 86 | 121·0 | 46·6 | 262 | 31 | 10·80 | 17·0 | 32 | 125·5 |
| November .. | ·829 | ·071 | 53·6 | 61·0 | 48·9 | 12·2 | 51·0 | 46·2 | 352 | 84 | 116·1 | 44·1 | 271 | 31 | 6·05 | 11·5 | 38 | 133·8 |
| December .. | ·832 | ·070 | 53·3 | 62·0 | 47·5 | 14·5 | 47·8 | 41·6 | ·279 | 68 | 114·2 | 40·2 | 289 | 4 | 4·47 | 6·2 | 52 | 195·0 |
| Annual .. | 22·813 | 0·068 | 56·3 | 64·6 | 51·1 | 13·5 | 51·6 | 46 5 | 0·339 | 74 | 124·0 | 44·7 | 306 | 0 (N) | 59·55 | 113 | 44 | 2028·2 |
| Period of means. | 1900 January to 1910 December. | | 1899 May to 1910 April. | | | | 1900 January to 1910 December. | | | | 1899 May to 1910 April | 1900 January to 1910 December. | 1899 May to 1910 April | 1903 January to 1910 December. | 1899 May to 1910 April. | | | 1900 January to 1910 December. |

# Appendix VII.

MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1910.

| Abnormals of | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure .. .. .. | — 0·051 | — 0·052 | — 0·039 | — 0 031 | + 0·009 | — 0·024 | — 0·002 | — 0·030 | — 0·059 | — 0·020 | — 0·025 | + 0·025 | — 0·024 |
| Temperature of air .. .. .. .. .. | + 1·4 | + 1·4 | + 0·1 | + 1·1 | + 1·9 | + 0·1 | — 0·3 | — 0·1 | + 0·1 | + 0·8 | — 0·9 | — 0·8 | + 0 4 |
| Do. of evaporation .. .. .. | + 2·0 | + 1·2 | + 0·6 | + 1·4 | + 0 6 | + 0·7 | + 1·8 | + 1 6 | + 1·2 | + 1·4 | — 0·6 | — 1·0 | + 0·9 |
| Percentage of humidity .. .. .. .. | + 3 | Same as | + 2 | + 2 | — 3 | + 3 | + 9 | + 7 | + 5 | + 4 | + 2 | — 1 | + 0·3 |
| Greatest solar heat *in vacuo* .. .. .. .. | — 5·7 | — 6·2 | — 7·5 | — 4·1 | — 2 8 | — 12·2 | — 7·7 | — 12·1 | — 9·1 | — 3·1 | — 12·5 | — 3·9 | — 7·3 |
| Maximum in shade .. .. .. .. .. | + 1·4 | + 0·9 | + 0·6 | + 1 9 | + 2·9 | — 1·1 | — 1·6 | — 2·5 | — 1·4 | + 0·4 | — 1·9 | + 0·1 | Same as |
| Minimum in shade .. .. .. .. .. | — 0·3 | + 1·2 | — 1·1 | + 1·0 | + 0·8 | + 0·2 | — 0 4 | + 0·1 | Same as | + 0·9 | — 1·0 | — 2·5 | Same as |
| Do. on grass .. .. .. .. .. | + 1·0 | + 2·3 | — 0·5 | + 1·9 | + 1·2 | + 0·4 | — 0·2 | + 0·4 | + 0·3 | + 2·0 | — 0·2 | — 3·0 | + 0·5 |
| Rainfall in inches .. .. .. .. .. | — 0·69 | — 0·28 | — 0·39 | — 0·58 | — 2·11 | — 0·36 | + 4·21 | + 0·57 | — 0·90 | — 1·36 | + 2·57 | — 5·23 | .. |
| Do. since January .. .. .. .. .. | .. | — 0·97 | — 1·36 | — 1·94 | — 4·05 | — 4·41 | — 0 20 | + 0·37 | — 0·53 | — 1·89 | + 0·68 | — 4·55 | — 4·55 |
| General direction of wind .. .. .. . | 1 point E. | Same as | 1 point S. | 1 point S. | 1 point S. | Same as | 2 points S. | 1 point S. | 4 points W. | 7 points S. | 2 points N. | Same as | 1 point S. |
| Daily velocity in miles .. .. .. .. | — 1 | + 8 | Same as | + 8 | — 12 | — 35 | — 32 | — 33 | — 22 | — 8 | — 18 | — 26 | — 14 |
| Percentage of cloudy sky .. .. .. .. | — 5 | — 1 | — 10 | — 2 | — 6 | + 8 | — 14 | — 4 | Same as | — 7 | — 11 | — 18 | — 6 |
| Do. of bright sunshine .. .. .. .. | — 9·6 | — 9·5 | — 6·7 | + 0·2 | — 3 0 | — 24·5 | + 1·3 | — 11·5 | — 12·6 | — 11·2 | — 4·0 | + 4·7 | — 7·2 |

## Appendix VIII.

**Abstract** of the mean meteorological condition of Madras in the year 1910 compared with the average of past years.

| Mean values of | 1910. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure .. .. .. .. .. .. | 29·840 | 0·024 below. | 29·864 |
| Temperature of air .. .. .. .. .. .. .. | 81·5 | 0·4 above. | 81·1 |
| Do. of evaporation .. .. .. .. .. .. | 75 4 | 0·9 ,, | 74·5 |
| Percentage of humidity . .. .. .. .. .. | 75 | 3 ,, | 72 |
| Greatest solar heat *in vacuo* . .. .. .. .. | 132·4 | 7·3 below. | 139·7 |
| Maximum in shade .. .. .. .. .. . .. | 90·8 | Same as | 90·8 |
| Minimum in shade .. .. .. .. .. .. | 74·7 | Do. | 74·7 |
| Do. on grass .. .. .. .. .. .. .. | 72·4 | 0·5 above. | 71·9 |
| Rainfall in inches since January 1st on 85 days .. .. .. | 44·47 | 4 55 below. | 49·02 |
| General direction of wind .. .. .. .. .. .. | S.E. by S. | 1 point S. | S.E. |
| Daily velocity in miles .. .. .. .. .. .. .. | 157 | 14 below. | 171 |
| Percentage of cloudy sky .. .. .. .. .. .. | 43 | 6 ,, | 49 |
| Do. of bright sunshine .. .. .. .. .. | 51·2 | 7·2 ,, | 58·4 |

**Duration** and quantity of the wind from different points.

| From | Hours | Miles. | From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North .. | 143 | 889 | East .. | 211 | 1,074 | South .. | 205 | 1,367 | West .. | 261 | 1,855 |
| N. by E. .. | 445 | 2,479 | E. by S .. | 219 | 1,122 | S. by W. .. | 221 | 1,466 | W. by N... | 210 | 1,478 |
| N.N.E. .. | 319 | 1,903 | E.S.E. .. | 169 | 906 | S.S.W. .. | 251 | 1,825 | W.N.W. . | 141 | 1,065 |
| N.E. by N. | 327 | 1,984 | S.E. by E. | 305 | 1,654 | S.W. by S. | 232 | 1,536 | N.W. by W. | 145 | 983 |
| N.E. .. | 269 | 2,371 | S.E. .. | 415 | 2,881 | S.W. .. | 217 | 1,462 | N.W. .. | 91 | 498 |
| N.E. by E. | 392 | 2,366 | S.E. by S. | 882 | 6,606 | S.W. by W. | 246 | 1,514 | N.W. by N. | 110 | 581 |
| E.N.E. .. | 190 | 1,138 | S.S.E. .. | 643 | 5,184 | W.S.W. .. | 293 | 2,172 | N.N.W. .. | 98 | 572 |
| E. by N. .. | 151 | 808 | S. by E. .. | 292 | 2,015 | W. by S... | 323 | 2,391 | N. by W. | 187 | 1,198 |

There were 157 calm hours during the year. The resultant corresponding to the above numbers is represented by a South wind, blowing with a uniform daily velocity of 291 miles.

# Appendix IX.

MADRAS OBSERVATORY—Number of hours of wind from each point in the year 1910.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. | 4 | 21 | 16 | 76 | 71 | 172 | 67 | 75 | 74 | 53 | 16 | 26 | 5 | 39 | 1 | 2 | 1 | 1 | .. | . | 1 | 1 | 1 | 1 | . | .. | .. | .. | .. | . | .. | 1 | 19 |
| February .. | 1 | 3 | 29 | 31 | 77 | 97 | 62 | 34 | 72 | 42 | 21 | 28 | 43 | 51 | 27 | 3 | .. | 2 | 1 | 6 | 5 | .. | .. | .. | .. | .. | .. | . | 5 | 4 | 2 | 2 | 24 |
| March .. | .. | .. | .. | .. | . | . | 1 | 1 | 14 | 13 | 36 | 104 | 103 | 209 | 116 | 11 | 30 | 20 | 36 | 19 | 6 | 3 | 5 | 1 | .. | .. | .. | . | .. | | .. | .. | 16 |
| April .. | .. | .. | .. | .. | .. | 1 | 2 | 1 | .. | 2 | 5 | 9 | 93 | 189 | 175 | 70 | 42 | 45 | 37 | 24 | 5 | 5 | 3 | 2 | | 1 | .. | .. | .. | 2 | .. | . | 7 |
| May .. .. | 2 | .. | 3 | .. | .. | 1 | 5 | .. | 3 | 5 | 5 | 19 | 51 | 158 | 160 | 42 | 35 | 27 | 50 | 31 | 26 | 14 | 22 | 20 | 18 | 19 | 9 | 7 | 1 | 2 | 3 | 1 | 7 |
| June .. .. | 1 | 5 | 2 | .. | 2 | .. | 2 | 3 | .. | 7 | 16 | 30 | 26 | 19 | 63 | 48 | 22 | 44 | 36 | 30 | 33 | 58 | 68 | 70 | 39 | 33 | 32 | 10 | 6 | 5 | 7 | | 3 |
| July .. .. | 8 | 5 | .. | 5 | 6 | 8 | 6 | 3 | 17 | 22 | 19 | 27 | 26 | 72 | 28 | 31 | 7 | 22 | 30 | 33 | 27 | 42 | 52 | 70 | 44 | 33 | 17 | 22 | 16 | 14 | 12 | 8 | 9 |
| August .. | 2 | 2 | 1 | 2 | .. | 2 | 5 | 15 | 6 | 24 | 5 | 11 | 31 | 38 | 5 | 14 | 22 | 18 | 31 | 27 | 60 | 59 | 58 | 59 | 65 | 39 | 29 | 28 | 27 | 28 | 12 | 4 | 14 |
| September .. | 1 | .. | 1 | .. | .. | 1 | .. | 1 | 5 | 5 | 8 | 15 | 15 | 16 | 10 | 42 | 5 | 16 | 11 | 35 | 35 | 46 | 42 | 83 | 74 | 61 | 40 | 72 | 18 | 22 | 16 | 3 | 11 |
| October .. | 24 | 52 | 18 | 14 | 14 | 22 | 15 | 11 | 18 | 15 | 22 | 29 | 22 | 89 | 48 | 16 | 28 | 20 | 18 | 9 | 14 | 10 | 38 | 11 | 12 | 14 | 8 | 3 | 14 | 17 | 31 | 39 | 29 |
| November .. | 67 | 182 | 53 | 25 | 18 | 38 | 16 | 4 | 1 | 31 | 16 | 7 | . | 2 | 10 | 13 | 3 | 6 | 1 | 15 | 5 | 8 | 4 | 6 | 9 | 10 | 6 | 3 | 4 | 16 | 14 | 112 | 15 |
| December .. | 33 | 175 | 196 | 174 | 81 | 50 | 11 | 3 | 1 | .. | .. | . | .. | .. | .. | .. | .. | . | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | . | .. | .. | 17 | 3 |
| Annual total .. | 143 | 445 | 319 | 327 | 269 | 392 | 190 | 151 | 211 | 219 | 169 | 305 | 415 | 882 | 643 | 292 | 265 | 221 | 251 | 232 | 217 | 246 | 293 | 323 | 261 | 210 | 141 | 145 | 91 | 110 | 98 | 187 | 157 |

# Appendix X.

MADRAS OBSERVATORY.—Number of miles of wind from each point in the year 1910.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. .. .. | 14 | 104 | 94 | 481 | 572 | 1172 | 512 | 397 | 296 | 286 | 94 | 109 | 34 | 179 | 10 | 14 | 6 | 7 | .. | .. | 8 | 3 | 8 | 4 | .. | .. | .. | .. | .. | .. | .. | 14 | 4418 |
| February .. .. .. .. | 3 | 10 | 120 | 162 | 620 | 448 | 297 | 184 | 436 | 254 | 106 | 111 | 241 | 370 | 109 | 21 | .. | 15 | 5 | 44 | 34 | .. | .. | .. | .. | .. | .. | .. | 19 | 14 | 10 | 8 | 3641 |
| March .. .. .. .. .. | .. | .. | .. | .. | .. | .. | 7 | 2 | 34 | 58 | 113 | 505 | 692 | 1488 | 908 | 49 | 182 | 149 | 273 | 140 | 55 | 12 | 34 | 9 | .. | .. | .. | .. | .. | .. | .. | .. | 4710 |
| April .. . .. .. .. | .. | .. | .. | .. | .. | 14 | 21 | 12 | .. | 24 | 41 | 51 | 605 | 1622 | 1586 | 590 | 332 | 344 | 369 | 240 | 44 | 29 | 24 | 9 | .. | 3 | .. | .. | .. | 8 | .. | .. | 5968 |
| May .. .. .. .. .. | 18 | .. | 27 | . | .. | 11 | 27 | .. | 26 | 44 | 50 | 174 | 435 | 1501 | 1527 | 338 | 247 | 208 | 394 | 272 | 222 | 116 | 213 | 194 | 175 | 199 | 97 | 80 | 9 | 18 | 27 | 8 | 6657 |
| June .. .. .. .. .. | 9 | 15 | 12 | .. | 23 | .. | 21 | 22 | .. | 56 | 175 | 239 | 232 | 168 | 482 | 307 | 199 | 295 | 225 | 221 | 239 | 415 | 559 | 581 | 307 | 272 | 287 | 73 | 43 | 43 | 26 | .. | 5546 |
| July .. .. .. .. .. | 50 | 20 | .. | 27 | 46 | 61 | 42 | 19 | 124 | 94 | 119 | 198 | 221 | 528 | 155 | 191 | 60 | 124 | 195 | 195 | 162 | 286 | 436 | 563 | 386 | 192 | 117 | 154 | 112 | 101 | 95 | 65 | 5138 |
| August .. .. .. .. | 6 | 8 | 3 | 6 | .. | 9 | 25 | 54 | 28 | 78 | 43 | 66 | 195 | 179 | 37 | 85 | 139 | 128 | 197 | 169 | 383 | 333 | 447 | 438 | 397 | 239 | 201 | 175 | 112 | 109 | 51 | 20 | 4360 |
| September .. .. .. .. | 5 | . | 4 | .. | .. | 5 | .. | 4 | 34 | 28 | 27 | 65 | 62 | 70 | 43 | 261 | 80 | 80 | 68 | 165 | 195 | 237 | 285 | 507 | 478 | 357 | 227 | 461 | 108 | 66 | 76 | 13 | 4011 |
| October .. .. .. .. | 130 | 209 | 124 | 43 | 88 | 133 | 57 | 73 | 86 | 94 | 92 | 101 | 164 | 489 | 245 | 77 | 98 | 86 | 98 | 39 | 95 | 53 | 146 | 56 | 69 | 71 | 42 | 13 | 72 | 79 | 173 | 216 | 3611 |
| November .. .. .. .. | 442 | 1256 | 312 | 200 | 105 | 118 | 38 | 20 | 4 | 106 | 46 | 35 | . | 12 | 82 | 82 | 24 | 30 | 1 | 51 | 25 | 30 | 20 | 30 | 43 | 145 | 94 | 27 | 23 | 143 | 114 | 748 | 4406 |
| December .. . .. .. | 212 | 857 | 1207 | 1065 | 917 | 395 | 91 | 21 | 6 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 106 | 4877 |
| Annual .. | 889 | 2479 | 1903 | 1984 | 2371 | 2366 | 1138 | 808 | 1074 | 1122 | 906 | 1654 | 2881 | 6606 | 5184 | 2015 | 1367 | 1466 | 1825 | 1536 | 1462 | 1514 | 2172 | 2391 | 1855 | 1478 | 1065 | 983 | 498 | 581 | 572 | 1198 | 57343 |

# Appendix XI.

MADRAS OBSERVATORY.—Number of inches of rain from each point in the year 1910.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. | 0·02 | 0·02 | . | 0·03 | .. | .. | .. | 0·13 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| February .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| March .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | . | . | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | . | .. | .. | .. | .. | .. |
| April .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·04 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| May .. | .. | | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·01 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| June .. | 0·04 | 0·13 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·13 | .. | 0·14 | .. | .. | 0·07 | 0·10 | 0·15 | .. | 0·51 | | 0·02 | 0·02 | 0·04 | .. | 0·02 | 0·02 | 0·14 | 0·22 | .. | .. |
| July .. | 1·79 | 0·11 | .. | 0·07 | 0·27 | 0·07 | .. | . | 0·16 | .. | .. | 0·05 | 0·32 | .. | .. | .. | 0·07 | .. | 0·07 | 2·18 | 0·05 | 0·63 | 0·22 | 0·28 | 0·53 | 0·01 | .. | .. | 0·19 | .. | .. | 1·01 | .. |
| August .. | 0·26 | 0·02 | 0·07 | 0·30 | .. | .. | 0·50 | .. | .. | .. | 0·21 | .. | 0·02 | .. | .. | 0·30 | 0·05 | 0·56 | 0·27 | 0·02 | 0·30 | 0·28 | 0·13 | 0·47 | 0·03 | 0·12 | 0·05 | 0·22 | 0·60 | .. | 0·13 | 0·05 | 0·17 |
| September .. | .. | .. | .. | .. | .. | .. | .. | 0·04 | .. | .. | .. | .. | .. | .. | .. | 0·01 | .. | 0·23 | .. | 0·22 | 0·57 | 0·01 | 0·08 | 0·02 | 0·10 | 0·05 | 0·05 | 0·72 | 0·11 | 0·03 | 1·40 | 0·04 | 0·11 |
| October .. | 0·29 | 0·06 | 0·85 | 0·01 | 0·34 | 0·67 | 0·48 | 0·67 | 1·73 | 0·45 | 0·12 | .. | 0·02 | .. | 0·08 | 0·05 | 0·10 | .. | .. | .. | 0·05 | 0·29 | 0·04 | .. | .. | .. | .. | .. | 0·01 | 1·20 | 0·19 | 1·91 | 0·03 |
| November .. | .. | 2·26 | 0·19 | .. | .. | .. | .. | .. | .. | .. | 0·34 | .. | .. | .. | .. | .. | . | 1·42 | .. | .. | 0·07 | 0·45 | .. | .. | 0·58 | 1·65 | 1·57 | 0·80 | 0·40 | 2·72 | 1·22 | 2·11 | .. |
| December .. | .. | .. | .. | .. | .. | 0·05 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Annual .. | 2·40 | 2 60 | 1·11 | 0·41 | 0·61 | 0·79 | 0·98 | 0·84 | 1·89 | 0·45 | 0·67 | 0·05 | 0·49 | .. | 0·22 | 0·36 | 0·26 | 2·28 | 0·44 | 2·57 | 1·04 | 2·18 | 0·47 | 0·79 | 1·26 | 1·87 | 1·67 | 1·76 | 1·33 | 4·09 | 3·16 | 5·12 | 0·31 |

# Appendix XII.

MADRAS OBSERVATORY.—Wind, cloud, and bright sunshine, 1910.

| Month. | Wind resultant. | | Clouds (0—10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H. | 16 H. | 20 H. | Mean. | Average per day. | Greatest number of hours in a day. |
| | MILES. | | | | | | | HOURS. | HOURS. |
| January .. .. | 122 | E.N.E. | 3·3 | 3·7 | 3·3 | 2·4 | 3·2 | 7·3 | 8·6 |
| February .. .. | 94 | E. by N. | 2·7 | 2·6 | 2·5 | 1·5 | 2·3 | 8·4 | 10·2 |
| March .. .. | 136 | S.E. by S. | 2·0 | 1·8 | 1·2 | 0·7 | 1·4 | 8·7 | 10·3 |
| April .. .. | 180 | S.S.E. | 3·7 | 3·0 | 2·0 | 1·7 | 2·6 | 9·5 | 11·6 |
| May .. .. | 146 | S. by E. | 4·3 | 3·4 | 2·9 | 2·2 | 3·2 | 8·0 | 11·1 |
| June .. .. | 102 | S.W. by W. | 7·9 | 7·7 | 6·7 | 6·3 | 7·2 | 8·9 | 2·8 |
| July .. .. | 62 | S.W. by W. | 6·1 | 5·9 | 5·8 | 5·0 | 5·7 | 8·7 | 4·3 |
| August .. .. | 82 | W.S.W | 6·5 | 6·9 | 6·4 | 5·2 | 6·3 | 10·8 | 3·7 |
| September .. .. | 86 | W. by S. | 6·2 | 5·7 | 7·0 | 5 8 | 6·2 | 8·5 | 3·8 |
| October .. .. | 17 | E.S.E. | 5·5 | 5·4 | 5·4 | 4·3 | 5·2 | 9·8 | 4·8 |
| November . .. | 101 | North. | 4·6 | 5·2 | 5·0 | 4·5 | 4 8 | 9·2 | 5·5 |
| December .. .. | 150 | N.E. by N. | 3·2 | 3·8 | 3·8 | 2·5 | 3·4 | 7·0 | 8·6 |
| Annual .. | 291 | South. | 4·7 | 4·6 | 4·3 | 3·5 | 4·3 | 8·7 | — |

# Appendix XIII.

## Mean Monthly and Annual Meteorological Results at the Madras Observatory in 1910.

| — | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer. Mean. | Dry bulb thermometer. Max. | Dry bulb thermometer. Min. | Dry bulb thermometer. Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. By Blanford's tables. | Relative humidity. By Blanford's tables. | Sun Max. *in vac.* | Min. on grass. | Wind. Daily velocity. | Wind. Mean direction. | | Rain. Amount. | Rain. Days. | Cloudy sky. | Bright sunshine. | Dew point. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | PTS. | | INCHES. | NO. | CENTS. | HOURS. | ° |
| January .. | 29·947 | 0·120 | 76·5 | 86.0 | 67·2 | 18·8 | 71·2 | 66·7 | 0·693 | 76 | 132·7 | 64·1 | 143 | 6 | E. N. E. | 0·20 | 4 | 32 | 227·6 | 67·5 |
| February .. | ·913 | ·117 | 78·1 | 87·5 | 69·1 | 18·4 | 72·0 | 68·3 | ·708 | 73 | 133·5 | 66·1 | 130 | 8 | E. | .. | .. | 23 | 235·7 | 67·8 |
| March .. | ·866 | ·130 | 80·1 | 89·8 | 71·0 | 18·8 | 74·5 | 70·5 | ·781 | 76 | 133·0 | 68·1 | 152 | 13 | S. E. by S. | .. | .. | 14 | 268·5 | 70·7 |
| April .. | ·795 | ·131 | 85·1 | 94·8 | 78·2 | 16·6 | 79·0 | 76·6 | ·909 | 76 | 137·6 | 76·6 | 199 | 14 | S. S. E. | 0·04 | 1 | 26 | 286·0 | 75·0 |
| May .. | ·744 | ·129 | 88·6 | 100·7 | 81·6 | 19·1 | 78·9 | 75·7 | ·858 | 64 | 140·2 | 80·1 | 215 | 16 | S. | 0·01 | 1 | 32 | 247·7 | 72·8 |
| June .. | ·679 | ·116 | 86·5 | 97·2 | 80·5 | 16·7 | 77·3 | 74·7 | ·816 | 65 | 128·3 | 79·0 | 185 | 19 | S.W. by S. | 1·75 | 9 | 72 | 85·2 | 71·4 |
| July .. | ·718 | ·119 | 84·2 | 94·0 | 78·1 | 15·9 | 77·7 | 74·7 | ·864 | 74 | 131·0 | 76·4 | 166 | 18 | S. S. W. | 8·08 | 14 | 57 | 133·6 | 73·4 |
| August .. | ·719 | ·112 | 83·2 | 91·2 | 77·4 | 13·8 | 77·6 | 74·9 | ·874 | 77 | 127·9 | 75·8 | 141 | 20 | S. W. | 5·13 | 14 | 63 | 114·2 | 73·8 |
| September . | ·719 | ·129 | 83·1 | 91·9 | 77·1 | 14·8 | 77·5 | 74·3 | ·868 | 77 | 132·2 | 75·3 | 134 | 22 | W. S. W. | 3·79 | 14 | 62 | 114·1 | 73·7 |
| October .. | ·822 | ·125 | 81·4 | 89·4 | 76·1 | 13·3 | 77·0 | 74·9 | ·871 | 82 | 136·0 | 74·8 | 115 | 14 | S. S. E. | 9·64 | 16 | 52 | 149·3 | 74·0 |
| November .. | ·899 | ·116 | 76·6 | 83·1 | 71·3 | 11·8 | 72·3 | 69·6 | ·742 | 81 | 124·9 | 69·3 | 147 | 0 | N. | 15·78 | 11 | 48 | 165·3 | 69·3 |
| December .. | 30·003 | ·108 | 74·7 | 83·7 | 67·0 | 16·7 | 69.6 | 66·3 | ·657 | 76 | 131·9 | 63·4 | 157 | 2 | N. N. E. | 0·05 | 1 | 34 | 216·7 | 65·1 |
| Annual .. | 29·819 | 0·121 | 81·5 | 90·8 | 74·7 | 16·2 | 75·4 | 72·3 | 0·803 | 75 | 132·4 | 72·4 | 157 | 13 | S. E. by S. | 44·47 | 85 | 43 | 2,243·9 | 71·2 |

## Extreme Monthly Meteorological Records at the Madras Observatory in 1910.

| — | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry bulb thermometer. Highest. | | Dry bulb thermometer. Lowest. | | Wet bulb. Lowest. | | Humidity. Lowest. | | Sun Th. *in vacuo.* Highest. | | Grass therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY. |
| January .. | 30·082 | 24 | 29·749 | 11 | 0·333 | 87·2 | 27 | 63·8 | 24 | 63·0 | 23 | 50 | 24 | 136·8 | 27 | 60·4 | 17, 18 | 281 | 5 | 66 | 15 | 0·13 | 29 |
| February .. | ·125 | 4 | ·755 | 19 | ·370 | 90·9 | 21 | 62·5 | 9 | 61·9 | 9 | 45 | 25 | 139·4 | 20 | 59·5 | 9 | 250 | 3 | 82 | 16 | .. | .. |
| March .. | ·037 | 13 | ·716 | 31 | ·321 | 97·2 | 20 | 65·6 | 18 | 65·6 | 18 | 52 | 23 | 140·2 | 8 | 61·7 | 18 | 223 | 21 | 91 | 13 | .. | .. |
| April .. | 29·913 | 30 | ·638 | 12 | ·275 | 101·7 | 24 | 71·1 | 7 | 71·1 | 7 | 44 | 24 | 143·4 | 24 | 68·0 | 7 | 277 | 21 | 122 | 7 | 0·04 | 4 |
| May .. | ·945 | 1 | ·552 | 27 | ·393 | 112·9 | 20 | 77·6 | 2 | 72·1 | 21 | 23 | 20 | 148·4 | 22 | 75·2 | 4 | 269 | 20 | 153 | 10,14 | 0·01 | 26 |
| June .. | ·835 | 30 | ·516 | 24 | ·319 | 104·5 | 4 | 73·1 | 23 | 72·3 | 8 | 37 | 4, 5 | 149·5 | 10 | 73·0 | 23 | 237 | 8 | 129 | 19,30 | 0·56 | 10 |
| July .. | ·874 | 9 | ·535 | 2 | ·339 | 102·4 | 6 | 73·9 | 28 | 72·4 | 9 | 37 | 5 | 142·5 | 6 | 72·4 | 10 | 303 | 4 | 94 | 25 | 4·58 | 27 |
| August .. | ·841 | 22 | ·592 | 3 | ·249 | 96·9 | 13 | 72·7 | 17 | 71·2 | 2 | 46 | 13 | 139·4 | 10 | 70·8 | 2 | 210 | 2 | 42 | 28 | 1·11 | 19 |
| September .. | ·832 | 17 | ·563 | 28 | ·269 | 95·1 | 7 | 71·7 | 13 | 70·7 | 30 | 52 | 27 | 143·5 | 11 | 71·8 | 13 | 185 | 3 | 85 | 17 | 1·49 | 13 |
| October .. | ·959 | 26 | ·654 | 1 | ·305 | 97·4 | 2 | 72·5 | 23 | 72·5 | 23 | 47 | 1, 3 | 142·7 | 7 | 72·4 | 23 | 179 | 1 | 32 | 13 | 2·50 | 28 |
| November .. | 30·042 | 20 | ·624 | 6 | ·318 | 89·7 | 13 | 62·5 | 27 | 62·1 | 27 | 45 | 16 | 143·4 | 11 | 59·6 | 27 | 267 | 6 | 57 | 13 | 5·47 | 5 |
| December .. | ·129 | 26 | ·886 | 10 | ·243 | 85·5 | 24 | 62·3 | 18 | 62·1 | 18 | 56 | 8 | 135·5 | 17 | 58·8 | 18 | 206 | 5 | 81 | 18 | 0·05 | 29 |

# KODAIKĀNAL AND MADRAS OBSERVATORIES.

## REPORT FOR THE YEAR 1911.

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### I.—Kodaikānal Observatory.



### II.—Madras Observatory.

# KODAIKĀNAL AND MADRAS OBSERVATORIES.

## I.—REPORT OF THE KODAIKĀNAL OBSERVATORY FOR THE YEAR 1911.

**Staff.**—The staff of the Observatory on December 31, 1911, was as follows :—

| | |
|---|---|
| Director .. .. .. .. | J. Evershed. |
| Assistant Director .. .. .. | T. Royds, D.Sc. |
| First Assistant .. .. .. | S. Sitarama Aiyar, B.A. |
| Second Assistant .. .. .. | G. Nagaraja Aiyar. |
| Third Assistant .. .. .. | A. Y. Subrahmanya Aiyar, B.A. |
| Fourth Assistant .. .. .. | S. Balasundaram Aiyar. |
| Writer .. .. .. .. | L. N. Krishnaswamy Aiyar. |
| Photographic Assistant .. .. | R. Krishna Aiyar. |

Mr. C. Michie Smith, C.I.E., retired from service as Director on January 14 (forenoon), 1911, but was appointed to special duty from that date to March 31, 1911, in connection with the electric installation work. Dr. Royds was appointed as Assistant Director and joined duty on February 28 afternoon. The First Assistant was on privilege leave for 41 days from August 14 and the Third Assistant for 20 days from July 3.

The subordinate staff consists of a book-binder, an assistant book-binder, a mechanic, five peons, a boy peon for the dark room, and two lascars.

2. **Distribution of work.**—The Director and the Assistant Director have charge of the two spectroheliographs and of the large grating spectrograph. The First, Second, and Third Assistants are in charge of the work with the Cooke equatorial (spectroscopic), the Lerebour and Secretan equatorial (visual), the photoheliograph, the transit instrument and the seismometer. They have also to do the astronomical computing and the preparation of the observations for the press. The Fourth Assistant has charge of the clock comparisons and, with the help of the writer, is responsible for the whole of the meteorological work. The writer is responsible for the accounts, correspondence, and all office records. The Photographic Assistant has charge of most of the photographic developing, printing, etc.

3. **Buildings and grounds.**—Work was begun early in the year on the electric power house and by the end of December the building was practically finished and most of the machinery installed. Much delay was caused by the difficulty in getting the heavier parts of the generating plant carried up the ghaut. A new fly wheel for the gas engine had to be cast as the one originally sent was too heavy to be carried up. It is expected that the installation will be completed and ready for work very soon after the new fly wheel has been received.

Plans and estimates for the house of the photographic assistant have been sanctioned by Government, and work was commenced on it towards the end of the year.

The pines planted in the compound in recent years are growing well and 500 more seedlings were planted during the year. The fire lines have been kept in good condition and extended so as to afford ample protection to the new plantations. The area planted with short grass has also been extended thus diminishing the risk of fire spreading if it should enter the compound.

4. **Instruments.**—The following are the principal instruments belonging to the Observatory, or in use, at the present time :—

Six-inch Cooke equatorial.

Six-inch Lerebour and Secretan equatorial remounted by Grubb, with a five-inch Grubb portrait lens of 36 inches focus attached.

Spectrograph I.—consisting of slit, collimator lenses of 4 and 7 feet focus, 2-inch parabolic grating, and camera tube without lens. Used in connection with an 11-inch polar siderostat and 6-inch Grubb lens of 40 feet focus.

A rhomb with ends cut at 45° mounted on a graduated circle can be placed in front of the slit so as to enable any part of the limb to be brought on to the slit.

Spectrograph II.—consisting of slit provided with vertical and horizontal millimetre scales for measuring position angles, and a reflecting device for rotating the sun's image, collimator lens of 210 c.m focus, 6-inch Michelson grating, and camera lens of about 4 metres focus. The spectrograph is used with the 18-inch concave mirror.

Spectroheliograph—with 18-inch siderostat and 12-inch Cooke photo-visual lens of 20 feet focus, by the Cambridge Scientific Instrument Company.

An auxiliary spectroheliograph attached to the above, made in the Observatory workshop.

Six-inch transit instrument and barrel chronograph, formerly the property of the Survey of India.

Six-prism table spectroscope—Hilger.

Photoheliograph Dallmeyer No. 4.

Theodolite, six-inch—Cooke.

Sextant.

Evershed spectroscope with three prisms for prominence and sunspot work, by Hilger.

Mean time clock, Kullberg 6326.

Do. Shelton.

Mean time Chronometer, Kullberg 6299.

Sidereal chronometer, Kullberg 6134.

Tape chronograph, Fuess.

Micrometer for measuring spectrum photographs. Hilger.

Dividing engine, Cambridge Scientific Instrument Company, Limited.

Two Balfour Stewart actinometers.

Milne horizontal pendulum seismograph.

Induction coil with necessary adjuncts.

Small polar siderostat.

Universal instrument.

Complete set of meteorological instruments, including Richard barograph and thermograph, and wind recorders.

A high class screw cutting turning lathe by Messrs. Cooke & Sons.

Ångström Pyrheliometer.

An 18-inch concave mirror by Henry of Paris belonging to the Director is mounted in the spectroheliograph room for general spectrum work.

## OBSERVATIONS.

### (*a*) Solar Physics.

5. The following table shows for each day the solar observations that were made:—

# Table A.

## Solar Observations in 1911.

A = Spots observed. B = Spot spectra. C = Prominences. D = Photoheliograms. E = Spectroheliograms.

| Date. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 .. | — | A—CDE | A—CDE | ABCDE | A—CDE | A—*C*D*E* | A—*C*DE | A—CDE | A—*C*DE | A—CDE | A—*C*DE | A—CDE |
| 2 .. | A—*C*DE | A—CDE | A—*C*DE | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | — | A—CDE | A—CDE | A—*C*DE |
| 3 .. | A—CDE | A—*C*DE | A—CDE | A—CDE | A—CDE | A—CD*E* | A——D*E* | A—CDE | A—*C*DE | A—*C*D*E* | — | A———— |
| 4 .. | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | ABCDE | A—CDE | A—*C*D*E* | A—*C*DE | A——DE | A—CDE | A—CDE |
| 5 .. | A—CDE | A—CDE | A—*C*DE | A—CDE | A—CDE | A—CD*E* | A—*C*DE | A—*C*D*E* | A—*C*DE | A—*C*D*E* | A—CDE | A———*E* |
| 6 .. | A—CDE | A—CDE | A—CDE | AB*C*D*E* | A—*C*D*E* | A—CDE | A——D*E* | A—CDE | A—CDE | A—*C*DE | A—CDE | A———E |
| 7 .. | A—*C*DE | A—CDE | A—CDE | A—CDE | A—*C*DE | A—CDE | — | A—CDE | A—CD*E* | A—CDE | A—CDE | A———— |
| 8 .. | — | A—CDE | A—*C*DE | A—*C*DE | A—CDE | — | — | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE |
| 9 .. | A—CDE | A—*C*DE | A—CDE | A—CDE | A—CDE | — | A———— | A—CDE | A——D*E* | A—CDE | A—CDE | A—CDE |
| 10 .. | A—CDE | A—*C*DE | A—CDE | ABCDE | A—CDE | — | A—CDE | A—CDE | A—*C*D*E* | A—*C*DE | — | A——D*E* |
| 11 .. | A—CDE | A—CDE | A—CDE | A—CD*E* | A—CDE | — | — | A—CDE | A——DE | A—*C*DE | — | A—CDE |
| 12 .. | A—CDE | A—CDE | A—CDE | A—*C*DE | A—CDE | A—CD*E* | A———— | A—*C*DE | A—CDE | A—CDE | — | A—CDE |
| 13 .. | A—*C*DE | A—CDE | A—CDE | ABCDE | A—CDE | A—CDE | — | A—CDE | A—CDE | A—CDE | A—*C*DE | — |
| 14 .. | A—CDE | A—*C*DE | A—CDE | A—CD*E* | A—*C*DE | A—CDE | — | A—CDE | A—CDE | A—CDE | A—CDE | A———*E* |
| 15 .. | A—CDE | A—CDE | A—CDE | A—*C*DE | A——D*E* | A—CDE | A—*C*D*E* | A—CDE | A—CDE | — | A——DE | A—CDE |
| 16 .. | — | A—CDE | A—*C*DE | A—CDE | A—CDE | A—CDE | A——D*E* | A—CDE | A—CDE | A—*C*DE | A—CDE | A—CDE |
| 17 .. | A—CDE | A—CDE | A—CDE | A—*C*DE | A—CDE | A—CDE | — | A—CDE | A—CDE | A——D*E* | A—CDE | A—CDE |
| 18 .. | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | — | A——D*E* | A——D*E* | A——DE | A—CDE | A—*C*D*E* | A—*C*DE |
| 19 .. | A—CDE | A—CDE | A—CDE | A—*C*DE | A—*C*DE | A—*C*D*E* | — | A—CDE | A—CDE | A—*C*D*E* | A—CD— | A——D*E* |
| 20 .. | A—CDE | A—*C*D*E* | A—CDE | A—CDE | A—*C*DE | A—*C*D*E* | A——DE | A—CDE | A——D*E* | A—CDE | — | — |
| 21 .. | A—CDE | A—CDE | A—CDE | A—CDE | A—*C*DE | — | A—*C*D*E* | A——D*E* | — | A—CD*E* | — | — |
| 22 .. | A—CDE | A—*C*DE | A—CDE | A—CDE | A—*C*DE | A—*C*DE | A—CDE | — | A—CDE | A———— | A—*C*D*E* | A———— |
| 23 .. | A—*C*DE | A—*C*DE | A—CDE | A—*C*DE | A—CDE | A—CDE | — | A—CDE | A—CDE | A——D*E* | — | A—*C*DE |
| 24 .. | A—CDE | A—CDE | A—CDE | ABCDE | A—CDE | A—*C*DE | A——DE | A—CDE | A—*C*DE | A—CDE | A—*C*D*E* | — |
| 25 .. | A—CDE | A—CDE | A—CDE | ABCDE | A—CDE | A—*C*DE | A—*C*DE | A—CDE | A—CDE | A—CDE | ABCDE | A——D*E* |
| 26 .. | A—CDE | A—CDE | A—CDE | ABCDE | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE | A—CDE |
| 27 .. | A—CDE | A—*C*DE | A—*C*DE | ABCDE | A—CDE | A—*C*DE | A—CDE | A—*C*DE | A—CDE | A—CDE | ABCDE | A—CDE |
| 28 .. | A—*C*DE | A—CDE | A—CDE | ABCDE | A——D*E* | A—CDE | A—*C*DE | A——D*E* | A—CDE | A—CDE | A—CDE | A—CDE |
| 29 .. | A—CDE | | A—CDE | ABCDE | A——D*E* | A—CDE | A—*C*DE | A——DE | A—CDE | A—CDE | A—*C*DE | A—CDE |
| 30 .. | A—CDE | | A—CDE | A——D*E* | A—*C*DE | A—CDE | A—CDE | A—*C*DE | A—CDE | A—CDE | A—CDE | A—CDE |
| 31 .. | A—*C*DE | | A—CDE | | A—CDE | | A—*C*DE | A—CDE | | A——D*E* | | A—CDE |

*Note.*—When a letter is in italics, it means that on that day the observations were not complete.

**Solar Observations—Abstract.**

| — | 1911 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | January. | February. | March | April | May. | June. | July. | August. | September. | October | November. | December. | Total. |
| A | 28 | 28 | 31 | 30 | 31 | 24 | 23 | 30 | 28 | 30 | 23 | 27 | 333 |
| B | .. | .. | .. | 10 | .. | 1 | | . | .. | . | 2 | . | 13 |
| C | 28 | 28 | 31 | 29 | 28 | 24 | 15 | 26 | 24 | 25 | 22 | 18 | 298 |
| D | 28 | 28 | 31 | 30 | 31 | 24 | 21 | 30 | 28 | 29 | 23 | 21 | 324 |
| E | 28 | 28 | 31 | 30 | 31 | 24 | 21 | 30 | 28 | 29 | 22 | 24 | 326 |

There was a fall in the number of observations made as compared with 1910 due to less favourable atmospheric conditions, the number of days on which no observations were possible having risen from 10 to 32. On 26 days there was no sunshine recorded.

6. **Photographs of the sun** with the Dallmeyer photoheliograph were taken on 324 days as against 345 in 1910. Double exposures are taken twice a month for determining the error of orientation of the photographs. Six solar negatives were sent during the year to the Greenwich Observatory to complete its series out of the 7 which were asked for.

7. **Work with the Spectroheliograph.**—Monochromatic photographs of the sun's disc in "K" light were taken on 326 days and prominence plates on 281 days. The best disc plate of each day has been copied on an enlarged scale on bromide paper as heretofore, the prints being oriented and pasted in order on card sheets for convenience of reference. The prominence plates have been measured and the position angles and heights of all the prominences recorded. Duplicates of the disc plates have been sent to South Kensington for measurement as in former years, and in exchange prominence plates have been received from South Kensington.

A new autocollimating spectroheliograph constructed in the observatory workshop has been completed, and this was brought into regular use on April 1st. With this instrument photographs of the sun's disc in H$\alpha$ light were obtained on 165 days. The principal features shown on these plates are drawn by projection on the 8-inch charts used for recording sunspots and prominences, and the heliographic positions are read off from the ruled lines on the charts. The H$\alpha$ absorption markings are found to be very closely associated with the prominences and the distribution of the prominences on the disc as well as at the limb is now being studied

8. **Grating Spectrograph.**—High dispersion solar spectra have been photographed whenever the conditions permitted, and the special lines of research which have been prosecuted include the following :—

(*a*) Radial and other movements in spots.
(*b*) Pressure in spots.
(*c*) Motion of calcium vapour in spots, in flocculi, and in undisturbed regions of the photosphere.
(*d*) Motion in the line of sight of prominences for determining the angular speed of the sun's rotation at different heights above the photosphere.

Large spots were too few in number to admit of much progress in regard to radial motion effects, but a few plates have been obtained and measured. It has been found that whilst the outward radial motion appears to be an invariable and necessary accompaniment of spot formation, the inward movement of the higher levels is absent in the case of some spots showing very intense calcium emission.

Mr. Royds has obtained and measured about 50 plates of the H and K lines at the centre of the disc in undisturbed regions for estimating the vertical movements of circulation of calcium vapour. His results in general confirm those of St. John at Mount Wilson in showing a general ascending movement of the emitting gas, and a descending movement of the high-level absorbing gas; but the values obtained in kilometers per second are considerably smaller than the Mount Wilson determinations.

The measures of wave-length of $K_2$ in flocculi do not indicate any ascending motion, as was anticipated, but on the contrary give evidence of a slight descending movement relative to the iron vapour of the reversing layer. A sharp distinction must therefore be recognized between the larger masses of emitting vapour known as flocculi, and the small bright points all over the disc which show an ascending movement.

The H and K lines in the prominences have been measured in over 60 plates, and the average angular velocities obtained show a large excess over the corresponding velocities found by Adams for the chromosphere, which itself rotates faster than the general body of the sun. The excess is greater for the east limb than for the west.

9. **Visual Observations**.—Sunspots and prominences have been observed and recorded as in former years using paper charts with 5° lines of heliographic latitude and longitude impressed upon them by the cyanotype process. The solar phenomena observed are marked on these charts which are subsequently bound up in half-yearly volumes

The visual work includes detailed observations of affected lines in spot spectra and bright lines in metallic prominences. In accordance with the suggestion of the International Union for Solar Research special attention has been given to the behaviour of certain "arc" and "arc flame" lines in spot spectra and to the "enhanced" lines which occur in the region of spectrum examined. Owing to the great falling off in the solar activity only 6 spots have been studied in this way during the year and in 14 spots the behaviour of the C line and $D_3$ have been noted. Prominences were recorded visually on 298 days as against 313 in 1910 the difference being accounted for by the fact that there were 26 absolutely cloudy days in 1911 and only 10 in 1910. A somewhat unusual feature was that in December this work was possible on only 18 days. The visual record is compared with the spectro-heliograms and all prominences shown on the photographs but not in the drawings are added in blue pencil.

The visual and photographic records of prominences extending over eight years have been studied with reference to their relative frequency on the east and west limbs. The preliminary results show a marked preponderance of eastern over western prominences for each year with the possible exception of 1904, indicating an apparent influence of the earth tending to reduce prominence formation.

10. **Solar Radiation.**—No observations have been made with the Ångström pyrheliometer. The instrument was taken away by the Director-General of Observatories in February to be standardised and had not been returned at the end of the year.

No progress has been made in the method of estimating changes in the solar radiation by photographic comparisons between moonlight and first type stars on account of the difficulty in obtaining suitable apparatus for measuring the plates. It is hoped however that satisfactory results will be obtained with a Hartmann photographic photometer which the Director has obtained privately and which is expected shortly from Germany.

A new photographic telescope specially designed for the work is under construction in the observatory workshop.

*Summary of Results.*

11. **Sunspots**.—The following table shows the monthly numbers of new groups observed, the mean daily numbers of spots visible, and the distribution between the northern and southern hemispheres :—

| — | January. | February. | March. | April. | May. | June | July | August | September. | October | November. | December. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups .. .. | 4 | 6 | 7 | 8 | 8 | 4 | 4 | 5 | 2 | 2 | 3 | 3 | 56 |
| Daily number .. .. | 0·5 | 0 8 | 1·0 | 1 7 | 1 1 | 0·5 | 0 6 | 0·6 | 0 4 | 0 4 | 0 6 | 0·3 | 0·7 |
| North . .. .. | | . | .. | 3 | 2 | 2 | 1 | 3 | 1 | 2 | .. | 1 | 15 |
| South .. .. .. | 4 | 6 | 7 | 5 | 6 | 2 | 3 | 2 | 1 | . | 3 | 2 | 41 |
| Equator .. . | .. | .. | .. | . | .. | .. | . | .. | .. | .. | .. | .. | .. |

The very rapid decline in spot activity noted in the last report in comparing the years 1909 and 1910 has continued as is shown by the following figures :—

| | 1910. | 1911. |
|---|---|---|
| Number of new groups .. .. .. .. .. .. | 152 | 56 |
| Mean daily numbers .. .. .. .. .. .. | 1·8 | 0·7 |
| Large spot groups .. .. .. .. .. .. | 15 | 7 |
| Spot returns .. .. .. .. .. .. .. | 6 | *Nil* |
| Number of days on which no spots were seen .. .. .. | 56 | 158 |

The proportion of the southern spots to northern was higher than in 1910. The mean and extreme latitudes were not very different from what they were in 1910. A very faint dot was recorded at—37° on November 17, 1911. Excluding that, the mean latitudes were 7°·2 north and 9°·8 south and the extremes 2° and 12° in the northern hemisphere and 1° and 19° in the southern.

The following were the most important spot groups seen during the year :—

*January*—
No. 1951 A single spot of moderate size with a round and regular outline.

*February*—
No. 1958 A train of spots occupying 11° of longitude when the group was near the central meridian. C was reversed and $D_3$ was slightly dark on one day. A metallic prominence was observed on the limb of the sun before the day of its appearance.

No. 1960 contained spots of moderate size. C was occasionally observed to be reversed and $D_3$ dark. This group was also preceded by a metallic prominence.

*March*—
No. 1966 First appeared on the 29th as a group of small dots, but rapidly developed into two fairly large spots with smaller ones between.

*April*—
Nos. 1970, 1972, 1973 contained fairly large spots.

*May*—
No. 1983 contained a fairly large spot. C was slightly reversed near it on one day.

*August*—
No. 1993 contained a moderate sized spot. On the 8th at $8^h$ $34^m$ C was reversed and dark C was slightly displaced to violet to the east of the spot, but the displacement had disappeared at $8^h$ $35^m$.

*September*—
No. 1997 a fairly large spot.

*October*—
No. 1999 a fairly large spot.

*November*—
No. 2003 a fairly large spot.

Disturbances in C and $D_3$ were very rare during the year. Those mentioned above are almost all that were observed.

12. **Prominences.**—The mean areas of prominences for each hemisphere of the sun are shown in the following table in which the figures for the previous year are given for comparison :—

*Mean daily profile Areas of Prominences.*

| | 1910. Square minutes. | 1911. Square minutes. |
|---|---|---|
| **North** .. .. .. .. .. .. | 2·03 | 1·27 |
| **South** .. .. .. .. .. .. | 2·07 | 1·64 |
| **Total** .. | 4·10 | 2·91 |

The reduction of area of only 28 per cent. compared with 1910 shows that the solar activity as regards prominences is to a large extent independent of the spot activity, which has fallen during 1911 to about one-third of its value in 1910.

The distribution of the prominences in latitude differs from that in 1910 in the development of a zone of great activity in the southern hemisphere between the parallels of 35° and 50°. This has caused a marked excess of southern prominences over northern. The parallels of 60° north and south as in 1910 mark the approximate limits of prominence formation towards the poles, but small and transient jets have been frequently recorded within the polar areas.

Metallic prominences were very infrequent only 24 being recorded during the year. Most of them were found in the sun-spot zones but, as in the previous year, a few were observed in high latitudes. The mean and extreme latitudes are given in the following table :—

*Metallic Prominences.*

| — | Number observed. | Mean latitude. | Extreme latitudes. | |
|---|---|---|---|---|
| North .. .. .. | 9 | 21°·5 | 0°·5 | 86°·5 |
| South .. .. .. | 15 | 28°·8 | 2°·0 | 71°·5 |

The prominence activity in each month may be estimated from the following table :—

*Number of Prominences.*

| Months. | Prominences one minute or more in height. | Metallic. | Eruptive. |
|---|---|---|---|
| January .. .. .. .. | 47 | 1 | 5 |
| February .. .. .. .. | 25 | 2 | 5 |
| March .. .. .. .. | 27 | 3 | 6 |
| April .. .. .. .. | 44 | 3 | 12 |
| May .. .. .. .. | 33 | 2 | 5 |
| June .. .. .. .. | 23 | 2 | 2 |
| July .. .. .. .. | 14 | .. | 3 |
| August .. .. .. .. | 43 | 3 | 6 |
| September .. .. .. .. | 42 | 1 | 12 |
| October .. .. .. .. | 51 | .. | 4 |
| November .. .. .. .. | 49 | 4 | 6 |
| December .. .. .. .. | 40 | 3 | 2 |

The following were the more noteworthy prominences observed during the year :—

*January.*—The highest prominence, 200″, was observed at latitude—35° east on the 29th. For three successive days from the 28th to the 30th tall prominences were seen in this region.

*February.*—An eruptive, rapidly changing prominence was recorded at latitude—32° west on the 24th. This attained to a height of 165″.

*April.*—One of the highest prominences ever recorded here was observed on the 2nd. It first appeared on the photographs as a long wide streamer issuing from a point in latitude—34° east in a northerly direction and nearly tangent to the limb. It was immediately found to be rising and a series of photographs was taken. These showed that the prominence ascended with an accelerating velocity and finally broke into fragments which quickly faded. The highest fragment was over 10′ above the limb at $11^{h}\ 24^{m}$.

*September.*—There was a prominence 200″ high recorded at + 32° east on the 8th.

*October.*—Prominences were observed at latitude—45° east continuously from the 6th to the 16th.

*November.*—The tallest prominence of the month was photographed on the 28th at latitude—50° west. It was 240″ in height at $10^h\ 35^m$.

*December.*—An eruptive prominence recorded at + 38° west on the 27th reached to a height of 145″ at $11^h\ 44^m$.

(*b*) OTHER OBSERVATIONS.

13. **Comets.**—Photographs were obtained of the spectra of comets 1911b (Kiess) and 1911c (Brooks) with an objective prism spectrograph attached to the South Dome Equatorial. Direct photographs of these objects were also obtained at the same times as the spectrum plates. Kiess' comet was photographed on five days between August 14th and 20th and Brooks' comet on seven days between August 25th and September 22nd, and again after conjunction with the sun on October 28th and 29th.

Excepting for the greater amount of detail shown on the spectrum plates of Brooks' comet obtained at the end of October no essential change occurred in the spectrum as the comet approached perihelion and the best plate of the series (October 28th) appears to be identical with the best spectrum of Halley's comet obtained with the same instrument in 1910. The spectrum of Kiess' comet although much fainter appears to be the same as the others.

14. **Time.**—The error of the standard clock is usually determined by reference to the $16^h$ signal from the Madras Observatory. This is rendered possible by the courtesy of the Telegraph Department which permits the Madras wire to be joined through to this observatory. The signal is received with accuracy on most days and all failures are at once reported to the officer in charge of the Trichinopoly division. Time determinations are made with the transit instrument, when necessary, as a check.

15. **Meteorology.**—Meteorological observations were carried on as in former years. Eye observations are made at $8^h$, $10^h$, and $16^h$ local mean time. Temperatures and pressures are recorded continuously by a Richard thermograph (wet and dry bulb) and barograph, and the mean temperatures and pressures are obtained from the traces, corrected by reference to the eye observations. The wind direction and velocity shown in appendix tables II and III are obtained from a Beckley anemograph, and the $8^h$ values for the Daily Weather Reports of Simla and Madras from a Robinson anemometer and a wind vane.

Comparative observations of the standard barometer were taken early in the year with a barometer brought by the Director-General of Observatories and the instrumental correction was determined to be + 0·009 inch instead of — 0·002 inch. The new correction has been used in the annual report since the beginning of 1910.

*Pressure.*—The mean pressure for the year was practically the same as the normal—there was an excess of 0·003 inch. Only in four months was the deviation more than 0·010 inch—the greatest amounts being a defect of 0·015 inch in January and an excess of 0·026 inch in October. The pressure was below normal in January, March and November and above in the other months.

*Temperature.*—The mean temperature of the year was 0°·3 above normal. In seven months it was above and in the other five months below normal. The greatest deviation was 1°·3 either way. The mean grass minimum temperature in February was only 31°·3 as against the normal of 38°·4.

*Humidity.*—The mean humidity for the year was 2% below normal. It was above in March, June, July and December and below in the other months. The greatest excess was 13% in December and the greatest defect 13% in August.

*Rain.*—The rainfall for the year exceeded the normal by 4·51 inches. In January, February, March, August, and September there was a total defect of 15·50 inches and in May, June, July, October, November and December a total excess of 19·92 inches.

*Wind.*—The average daily velocity for the year exceeded the normal by 19 miles. The average velocity was in defect only in three months February, March and September. The excess in November was 113 miles and the mean direction in that month was east by south against north by west which is the normal direction for November. The highest daily movement was 883 miles on November 22 and the lowest 120 miles on October 7.

*Transparency of the atmosphere.*—The transparency of the lower atmosphere as judged by the visibility of the Nilgiris, about 100 miles distant, was much below the average.

*Cloud and sunshine.*—On 26 days the sky was completely overcast, but the average "clear sky" for the whole year was practically the same as the normal. There were 2,114 hours of bright sunshine against an average of 2,028.

16. **Seismology.**—The Milne horizontal pendulum recorded 95 earthquakes during the year as against 81 in 1910. There were between 10 and 12 earthquakes in each of the months January, April, October, November and December. The largest and longest record continued for $4^h$ $48^m$ on January 3 and had its origin in Turkestan.

17. **Library.**—One hundred and ninety-two volumes were bound during the year.

18. **Publications.**—Bulletins Nos. XXIII and XXIV were published during the year and Bulletin No. XXV was in the press at the end of the year. The first two deal with prominence observations in 1910 and the last with the same observations in the first half of 1911. In addition to these the following papers were published :—

"On the Angular speed of rotation of a long enduring prominence" by J. Evershed (A.P.J. Vol. XXXIII, No. 1).

"The Autocollimating Spectroheliograph of the Kodaikānal Observatory" by J. Evershed (M.N., R.A.S., Vol. LXXI, No. 9).

"The Absorption markings in $H_\alpha$ spectroheliograms" by T. Royds (M.N., R.A.S., Vol. LXXI, No. 9.)

19. **General.**—The Director-General of Observatories inspected the Kodaikānal Observatory in February and the Director inspected the Madras Observatory in December.

The staff of the observatory worked well during the year. In the reduction of the prominence observations and the preparation of the bulletins for the press the Third Assistant Mr. Subrahmania Aiyar deserves special mention for his zeal in keeping the work well up-to-date.

THE OBSERVATORY, KODAIKANAL,
*7th February* 1912.

J. EVERSHED,
*Director, Kodaikanal and Madras Observatories.*

## II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1911.

**Staff.**—The computer was on privilege leave for one month and eleven days and the Frst Assistant for two months.

2. **Time Service.**—No change was made in the programme of Astronomical observations, which have been restricted, as usual, to meridian observations for time determinations. The system of time signals distributed from the Observatory also remains unchanged. The time gun at the Fort failed on 9 occasions and was fired correctly on 721 occasions out of 730, giving 98·8 as the percentage of successes. The gunner was absent on one occasion, the gun failed twice owing to defect in firing apparatus, on three occasions owing to bad tube, twice owing to faults on the line and lastly the gun was not fired on the occasion of the Coronation Durbar of Their Imperial Majesties at Delhi. The semaphore at the Port Office was dropped correctly at 1 P.M. on every day except 3, when it was dropped correctly at 2 P.M.

3. **Meteorological observations.**—In addition to the ordinary meteorological observations, extra observations were taken and special telegrams sent to Simla on 2 occasions and on 41 occasions to Calcutta.

4. **Buildings.**—Electric light and fans were fitted in the offices and in the quarters of the Deputy Director during the year.

5. **Instruments.**—The following is a list of the instruments at the Madras Observatory on the 31st December 1911 :—

(*a*) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton & Simms.
Sidereal Clock—Haswall.
,, Dent, No. 1408.
,, S. Reifler, No. 61.
Mean Time Clock—J. H. Agar Baugh, No. 105.
,, with galvanometer—Shepherd & Sons.
Meridian Circle—Troughton & Simms.
Mean Time Clock—J. Monk.
Mean Time Chronometer—V. Kullberg, No. 5394.
,, ,, No. 6544.
,, Parkinson and Frodsham, No. 2352.
Portable Transit Instrument—Dolland.
Portable Telescope with stand.
Tape Chronograph—R. Fuess.
Relay for use with the Chronograph—Siemens.

(*b*) *Meteorological.*

Richard's Barograph—No. 10, L. Casella.
,, Thermograph—No. 3618, L. Casella.
Beckley's Anemograph—Adie.
Sunshine Recorder—No. 149, L. Casella.
Anemoscope—P. Orr & Sons.
Nephoscope—Mons Jules Daboseq & Ph. Pellin.
Barometer, Fortin's—No. 1771, L. Casella.
,, No. 725, L. Casella (spare).
,, No. 1420, L. Casella (spare).
Dry Bulb Thermometer—No. 94221, L. Casella.
,, No. 38037, Negretti & Zambra (spare).
Wet Bulb Thermometer—No. 94219, L. Casella.
,, No. 38037, Negretti & Zambra (spare).
Dry Maximum Thermometer—No. 8581, Negretti & Zambra.
Dry Minimum Thermometer—No. 69047, L. Casella.
Wet Minimum Thermometer—No. 91753, Negretti & Zambra.
Sun Maximum Thermometer—No. 10479, Negretti & Zambra.
Grass Minimum Thermometer—No. 3377, Negretti & Zambra.
Raingauge (8″ diameter)—No. 1042, Negretti & Zambra.
Measure glass for above.
Raingauge (5″ diameter).
Measure glass for above.

The year was an abnormally dry one and very little rain fell till November 19th. During this time the level of the transit changed slowly and steadily in the same direction. After the heavy rain on 21st November it underwent a sudden

change in the opposite direction accompanied by some change in azimuth. At present the level error is very small and is almost steady. The rates of the Riefler and Dent Clocks have been very satisfactory. A new mean time clock by Mr. J. H. Agar Baugh was received towards the end of the year and has been mounted in the room to the west of the transit room. The electrical contacts with which it is fitted have not yet been connected and brought into use. It is proposed to divert the telegraph lines into this room from the Clock room in the Deputy Director's quarters.

6. **Weather summary.**—The following is a summary of the meteorological conditions at Madras during the year 1911 :—

*Pressure.*—Pressure was above normal in February, June, July, October and November and below normal in other months. The greatest excess was 0·043 inch in February and the greatest defect 0·034 inch in January The highest pressure recorded was 30·154 inches on February 12 and the lowest 29·548 inches on September 24.

*Temperature.*—The mean temperature of air was above normal in all months except February. The highest shade temperature recorded was 106°·4F. on June 1 and the lowest 62°·0F. on February 20. The highest temperature in the sun (150°·5) F. was recorded on July 30 and the lowest on grass was 58°·6F. on February 20.

*Humidity.*—Humidity was below normal in February and August and above normal during the other months.

*Wind.*—The wind direction was normal in February and December. It was more easterly than usual in January and November, more southerly than usual in March, April, May and October. The wind velocity was below the average throughout nearly the whole of the year. In November the mean daily velocity was 31 miles below normal.

*Cloud.*—The percentage of cloud was a little above normal in December and below normal in the remaining months.

*Sunshine.*—The percentage of bright sunshine was above normal in March, July, September and October and below normal during the rest of the year. The total number of hours of bright sunshine during the year was 2,249.

*Rainfall.*—The rainfall was above the average in September and December and below during the other months, the greatest excess being 2·93 inches in September and the greatest defect 5·09 inches in October. The total fall for the year was 36·53 inches and the monsoon rainfall from October 15 to the end of the year was 24·59 inches against an average of 26·00 inches. The heaviest fall on any day was 4·74 inches on November 21.

*General.*—The most noteworthy feature of the weather during the year was the deficient rainfall during the first eight months. From the 1st January up to nearly the middle of September the total rainfall at Madras was about 4 inches.

MADRAS OBSERVATORY,
16*th January* 1912.

R. LL. JONES,
*Deputy Director.*

# Appendix I.

KODAIKÁNAL Observatory Seismological Records in 1911.

| No. | Date | | P.T. commence G.M.T. | L.W. commence G.M.T. | Maxima G.M.T. | End. | Max. Amp. | Duration. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | 1911. | | H. M. | H. M. | H. M. | H. M. | MM. ″ | H. M. | |
| 1 | Jan. | 1 .. | 10 27·4 | 10 32·6 | 10 36·2 | 11 47 | 4·3 = 2·1 | 1 20 | |
| 2 | | 3 .. | 7 31·1 | 7 54·9 | 7 56·0 | 8 35 | 0·6 = 0·3 | 1 04 | |
| 3 | | 3–4 .. | 23 32·0 | 23 38·5 | .. (?) | 4 20 | 18 = 8·0 | 4 28 | Beyond range from 23 h. 41m. to 23 h. 54m. Turkestan. |
| 4 | | 4 .. | 8 33·0 | .. | .. | 8 57 | .. | 0 24 | Widening of line. |
| 5 | | 4 .. | 9 48·9 | 9 54·3 | 9 55·4 | 10 17 | 1·0 = 0·4 | 0 28 | |
| 6 | | 4 .. | 21 47·3 | 21 52·8 | 21 54·4 | 22 07 | 0·4 = 0·2 | 0 20 | |
| 7 | | 7 .. | 2 25·7 | 2 56·6 | 3 00·6 | 4 09 | 0·6 = 0·2 | 1 43 | |
| 8 | | 8 .. | 13 19·2 | .. | .. | 14 20 | .. | 0 01 | Do. |
| 9 | | 9 .. | 3 53·6 | 4 12·9 | 4 16·0 | 4 40 | 0·4 = 0·2 | 0 46 | |
| 10 | | 14 .. | 18 10·5 | .. | .. | 18 41 | .. | 0 31 | Do. |
| 11 | | 16 .. | 8 59·2 | .. | 9 25·4 | 9 54 | 0·5 = 0·2 | 0 55 | |
| 12 | Feb. | 13 .. | 14 07·6(?) | 14 18·8 | 14 19·8 | 14 35 | .. | 0 27(?) | Do. |
| 13 | | 18 .. | 18 41·3 | 18 51·5 | 18 56·1 | 22 30 | 9·5 = 5·4 | 3 49 | |
| 14 | | 23 . | 11 26·4 | .. | .. | 12 18 | .. | 0 52 | Do. |
| 15 | | 28 .. | 5 28·2 | 5 47·2 | 5 48·1 | 5 59 | 0·3 = 0·2 | 0 31 | |
| 16 | March | 11 .. | 3 37·7 | .. | .. | 4 44 | .. | 1 06 | Do. |
| 17 | | 14 .. | 21 08·0 | .. | .. | 22 12 | . | 1 04 | Do. |
| 18 | | 22 .. | 5 43·6 | 5 54·2 | 6 16·3 | 7 09 | 0·3 = 0·3 | 1 25 | |
| 19 | | 22 .. | 7 47·3 | 7 53·4 | 8 07·8 | 8 25 | 0·2 = 0·2 | 0 38 | |
| 20 | | 27 .. | 9 07·1 | .. | .. | 9 18 | .. | 0 11 | Do. |
| 21 | April | 4 .. | 16 14·1 | 16 19·2 | 16 21·2 | 16 24 | 0·3 = 0·1 | 0 10 | Lombarda. |
| 22 | | 7 .. | 7 01·4 | 7 06·8 | 7 41·3 | 8 07 | 0·4 = 0·2 | 1 06 | |
| 23 | | 10 .. | 19 02·7 | .. | .. | 19 38 | .. | 0 36 | Widening of line. |
| 24 | | 10 .. | 20 08·6 | .. | | 20 23 | .. | 0 14 | Do. |
| 25 | | 11 .. | 14 29·5 | 14 30·5 | 14 44·9 | 15 02 | 0·2 = 0·1 | 0 32 | |
| 26 | | 15 .. | 11 23·8 | .. | .. | 11 28 | | 0 04 | Do. |
| 27 | | 15 .. | 12 01·2 | 12 03·8 | 12 04·4 | 12 23 | 0·7 = 0·3 | 0 22 | |
| 28 | | 17 .. | 5 20·3 | .. | .. | 6 27 | .. | 1 07 | Do. |
| 29 | | 18 .. | 18 20·8 | 18 25·8 | 18 34·4 | 20 10 | 6·0 = 2·9 | 1 49 | |
| 30 | | 28 .. | 10 32·0 | .. | .. | 11 28 | .. | 0 56 | Do. |
| 31 | | 29 .. | 5 32·2 | 5 46·0 | 5 48·6 | 6 02 | 0·5 = 0·2 | 0 30 | |
| 32 | | 30 .. | 9 50·3 | .. | .. | 10 29 | .. | 0 39 | Do. |
| 33 | May | 4 .. | 13 34·5 | 13 43·5 | 13 46·9 | 14 11 | 0·7 = 0·3 | 0 37 | |
| 34 | | 4–5 .. | 23 48·0 | 23 57·9 | 0 30·6 | 3 05 | 2·5 = 1·2 | 3 17 | |
| 35 | | 11 .. | 4 19·7 | 4 24·1 | 4 26·4 | Between 4h. 51 m. and 5 h. 00 m. | 0·4 = 0·2 | 0 40(?) | Instrument adjusted 4 h. 51 m. to 5 h. 00 m. |
| 36 | | 27 .. | 20 33·6 | .. | .. | 21 26 | .. | 0 52 | Widening of line. |
| 37 | June | 1 .. | 14 41·2 | .. | .. | 14 55 | .. | 0 14 | Do. |
| 38 | | 3 .. | 21 12·4 | .. | .. | 21 48 | | 0 36 | Do. |
| 39 | | 7 .. | 11 24·4 | 12 27·4 | 12 43·3 | 14 57 | 4·5 = 2·3 | 3 33 | |
| 40 | | 8 .. | 0 12·0 | .. | .. | 1 03 | .. | 0 51 | Do<br>Line widened irregularly during high wind. |
| 41 | | 15 .. | .. | 14 35·1 | 14 47·7 | 18 08 | 13 = 5·5 | 3 33 | No P. TS. |
| 42 | | 17 .. | 5 26·0 | .. | .. | 6 01 | .. | 3 35 | Widening of line. |
| 43 | July | 4 .. | 13 39·0 | 13 43·3 | 13 48 5 | 15 14 | 5·0 = 1·9 | 1 35 | |
| 44 | | 5 .. | 2 17·2 | 2 29·0 | 2 31·8 | 3 24 | 0·7 = 0·3 | 1 07 | |
| 45 | | 5 .. | 18 51·0 | .. | .. | 19 42 | .. | 0 51 | Do. |
| 46 | | 8 .. | 2 32·0 | .. | .. | 3 15 | .. | 0 43 | Do. |
| 47 | | 12 .. | 4 17·2 | 4 19·2 | 4 42·8 | 9 28 | 12 = 4·9 | 5 11 | |
| 48 | | 19 .. | 10 29·0 | 10 29·7 | .. | 11 41 | .. | 1 12 | Do. |
| 49 | Aug.* | 8 .. | 14 58·6 | .. | .. | 15 17 | .. | 0 18 | Do. |
| 50 | | 8 .. | 18 38·1 | .. | .. | 19 01 | .. | 0 23 | Do. |
| 51 | | 16–17 .. | 22 52·4 | 22 59·5 | 23 20·3 | 2 42 | 6·8 = 2·6 | 3 51 | |
| 52 | | 18 .. | 3 10·7 | .. | .. | 3 39 | .. | 0 28 | Do. |
| 53 | | 21 .. | 16 47·3 | .. | .. | 18 15 | .. | 1 28 | Do. |
| 54 | | 23 .. | 16 45·8 | .. | .. | 17 23 | .. | 0 37 | Do. |
| 55 | Sept. | 15 .. | 13 40·6 | 13 53·1 | 14 46·3 | 15 29 | 0·5 = 0·2 | 1 48 | |
| 56 | | 17 .. | 3 52·2(?) | 4 19·1 | 4 25·9 | 6 43 | 1·6 = 0·6 | 2 51 | Instrument examined at 3h. 43 m. |
| 57 | | 20 .. | 5 49·8 | .. | .. | 6 13 | .. | 0 23 | Widening of line. |
| 58 | | 22 .. | 5 54·1 | 5 55·9 | 5 58·5 | 6 35 | 0·8 = 0·3 | 1 01 | |
| 59 | | 26 .. | 14 21·6 | .. | .. | 14 44 | .. | 0 22 | Do. |
| 60 | Oct. | 6 .. | 9 25·9 | 9 39·2 | 9 43·3 | 10 27 | 0·6 = 0·2 | 1 01 | |
| 61 | | 10 .. | 14 41·0 | .. | | 15 31 | .. | 0 50 | Do. |
| 62 | | 13 .. | 2 56·1 | 3 22·8 | 3 25·4 | 4 15 | 1·0 = 0·4 | 1 19 | |
| 63 | | 14 .. | 6 42·2 | .. | .. | 7 19 | .. | 0 37 | Do. |
| 64 | | 14 .. | 12 48·0 | 13 17·5 | 13 18·0 | 14 22 | 0·7 = 0·2 | 1 34 | |
| 65 | | 14 .. | 16 59·0 | 17 30·0 | 17 31·0 | 18 02 | 0·5 = 0·2 | 1 03 | |
| 66 | | 14–15 .. | 23 32·8 | 23 34·6 | 23 35·9 | 0 41 | >17·5=>6·2 | 1 08 | |
| 67 | | 16 .. | 0 34·1 | .. | .. | 0 55 | .. | 0 21 | Do. |

* Driving clock stopped at intervals July 20 and 21.

## Kodaikānal Observatory Seismological Records in 1911—*cont.*

| No. | Date. | | P.T. commence G.M.T. | | L.W. commence G.M.T. | | Maxima G.M.T. | | End. | | Max. Amp. | Duration. | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1911. | | H. | M. | H. | M. | H. | M. | H. | M. | MM. " | H. | M. | |
| 68 | Oct. | 17 .. | 12 | 14·9 | .. | | .. | | 13 | 05 | .. | 0 | 50 | Widening of line. |
| 69 | | 21 .. | 0 | 07·4 | .. | | .. | | 1 | 03 | .. | 0 | 56 | Do. |
| 70 | | 24 .. | 0 | 45·3 | .. | | .. | | 1 | 11 | .. | 0 | 26 | Do. |
| 71 | | 29 .. | 19 | 33·6 | .. | | .. | | 20 | 09 | .. | 0 | 35 | Do. |
| 72 | Nov. | 1 .. | 10 | 52·0 | .. | | .. | | 11 | 29 | .. | 0 | 37 | Widening of line. Nov. 3-4 clock not driving. |
| 73 | | 10 .. | .. | | 4 | 50·3 | 4<br>4 | 50·3<br>52·1 | 5 | 05 | 0·5 = 0·2<br>0·6 = 0·2 | 0 | 15 | No. P. Ts. |
| 74 | | 11 .. | 3 | 16·2 | 3 | 18·3 | 3 | 18·8 | 3 | 27 | 0·5 = 0·2 | 0 | 11 | |
| 75 | | 11 .. | 3 | 43·0 | 3 | 44·8 | 3 | 44·8 | 3 | 53 | 0·4 = 0·2 | 0 | 10 | |
| 76 | | 13 .. | 16 | 36·1 | 17 | 02·3 | 17 | 07·8 | 18 | 02 | 1·8 = 0·7 | 1 | 26 | |
| 77 | | 18 .. | 8 | 54·0 | .. | | .. | | 9 | 41 | .. | 0 | 47 | Widening of line. |
| 78 | | 20 .. | 15 | 16·0 | 15 | 27·2 | 15 | 28·7 | 15 | 46 | 0·5 = 0·2 | 0 | 30 | |
| 79 | | 21 .. | 19 | 41·6 | .. | | .. | | 20 | 00 | .. | 0 | 18 | Do. |
| 80 | | 22–23 .. | 23 | 18·3 | .. | | .. | | 0 | 21 | .. | 1 | 03 | Do. |
| 81 | | 28 .. | 16 | 04·9 | .. | | .. | | 16 | 53 | .. | 0 | 48 | Do. |
| 82 | | 30 .. | 11 | 07·8 | .. | | .. | | 11 | 53 | .. | 0 | 45 | Do. |
| 83 | | 30 .. | .. | | 23 | 48·4 | 23 | 49·4 | 24 | 00 | 0·4 = 0·2 | 0 | 12 | No P. Ts. |
| 84 | Dec. | 2 .. | .. ? | | 4 | 31·3 | 4 | 32·0 | 4 | 42 | 0·6 = 0·2 | 0 | 11 | Hour signal at 4h 30m. |
| 85 | | 7 .. | 0 | 22·8 | .. | | 0 | 25·9 | 1 | 15 | 0·4 = 0·2 | 0 | 52 | |
| 86 | | 7 .. | 15 | 05·2 | .. | | .. | | 15 | 16 | .. | 0 | 11 | Widening of line. |
| 87 | | 11 .. | 11 | 06·2 | 11 | 10·1 | 11 | 13·2 | 13 | 23 | 2·2 = 0·8 | 2 | 17 | |
| 88 | | 13 .. | 9 | 03·2 | .. | | .. | | 9 | 30 | .. | 0 | 27 | Do. |
| 89 | | 13 .. | 23 | 08·3 | .. | | .. | | 23 | 44 | .. | 0 | 36 | Do. |
| 90 | | 16 .. | 19 | 38·2 | 20 | 41·8 | 20<br>20 | 42·6<br>46·9 | 22 | 11 | 2·9 = 1·0<br>2·6 = 0·9 | 2 | 33 | |
| 91 | | 20 | 6 | 14·2 | 6 | 47·5 | 6 | 52·7 | 8 | 29 | 1·0 = 0·4 | 2 | 15 | |
| 92 | | 22 .. | 14 | 20·8 | .. | | .. | | 14 | 46 | .. | 0 | 25 | Do. |
| 93 | | 23 .. | 22 | 33·0 | .. | | .. | | 23 | 22 | .. | 0 | 49 | Do. |
| 94 | | 29 .. | 16 | 22·9 | .. | | .. | | 16 | 56 | .. | 0 | 33 | Do. |
| 95 | | 31 .. | 6 | 19·0 | 6 | 32·8 | 6 | 33·6 | 7 | 34 | 0·6 = 0·2 | 1 | 15 | |

# Appendix II.

Mean monthly and annual meteorological results at the Kodaikānal Observatory in 1911.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer. Mean. | Dry bulb thermometer. Max. | Dry bulb thermometer. Min. | Dry bulb thermometer. Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. By Blanford's tables. | Relative humidity. By Blanford's tables. | Sun Max. *in vac.* | Min. on grass. | Wind. Daily velocity. | Wind. Mean direction. | Wind. Mean direction. | Rain. Amount. | Rain. Days. | Clear sky. | Bright sun-shine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | POINTS. | POINTS. | INCHES. | NO. | CENTS. | HOURS. |
| January .. .. | 22·830 | 0·063 | 54·7 | 65·2 | 48·2 | 17·0 | 45·7 | 38·8 | 0·222 | 52 | 114·3 | 39·0 | 370 | 6 | E.N.E. | 0·21 | 1 | 65 | 249·6 |
| February .. | ·859 | ·067 | 53·7 | 66·7 | 45·2 | 21·5 | 44·9 | 37·5 | ·214 | 53 | 122 3 | 31·3 | 265 | 6 | E.N.E. | 0·24 | 1 | 78 | 253·9 |
| March .. .. | ·854 | ·071 | 58·2 | 70·0 | 50·6 | 19·4 | 50·4 | 43·9 | ·289 | 60 | 130·5 | 39·2 | 273 | 8 | E. | 0·14 | .. | 70 | 223·7 |
| April .. | ·840 | ·067 | 60·9 | 71·3 | 54·9 | 16·4 | 53·3 | 47·6 | ·330 | 62 | 129·7 | 45·3 | 288 | 5 | N.E. by E. | 4·37 | 9 | 60 | 216·2 |
| May .. .. | ·803 | ·067 | 60·9 | 70·2 | 54·8 | 15·4 | 55·2 | 50·3 | ·380 | 71 | 126·5 | 49·8 | 259 | 4 | N.E. | 9·70 | 12 | 49 | 208·7 |
| June .. .. | ·773 | ·056 | 57·4 | 63·5 | 53·7 | 9·8 | 54·2 | 50·4 | ·391 | 83 | 126·0 | 48·1 | 377 | 26 | W.N.W. | 7·19 | 17 | 29 | 121·6 |
| July .. .. | ·769 | ·055 | 55·5 | 60·5 | 52·0 | 8·5 | 53·1 | 49·4 | ·383 | 87 | 121·9 | 48·4 | 460 | 27 | N.W. by W. | 5·73 | 15 | 17 | 94·5 |
| August .. .. | ·780 | ·055 | 56·4 | 64·6 | 50·9 | 13·7 | 51·2 | 45·8 | 328 | 72 | 135·2 | 43·0 | 344 | 28 | N.W. | 2·08 | 6 | 45 | 214·1 |
| September .. | ·793 | ·075 | 56·8 | 64·2 | 52·1 | 12·1 | 53·5 | 48·8 | ·378 | 82 | 132·3 | 45·2 | 272 | 28 | N.W. | 2·89 | 8 | 33 | 122·6 |
| October .. | ·835 | ·076 | 55·4 | 62·1 | 50·7 | 11·4 | 52·8 | 48·2 | ·376 | 85 | 127·0 | 46·6 | 264 | 32 | N. | 13·72 | 16 | 30 | 130·3 |
| November .. | ·824 | ·067 | 54·6 | 61·5 | 49·6 | 11·9 | 51·2 | 45·3 | ·345 | 81 | 115·0 | 43·9 | 384 | 9 | E. by S. | 11·30 | 13 | 37 | 139·9 |
| December .. | ·837 | ·065 | 54·1 | 60·5 | 50·0 | 10·5 | 50·8 | 46·3 | ·342 | 81 | 111·8 | 44·9 | 347 | 6 | E.N.E. | 6·49 | 13 | 30 | 139·3 |
| Annual .. | 22·816 | 0·065 | 56·6 | 65·0 | 51·1 | 14·0 | 51·4 | 46·0 | 0·332 | 72 | 124·4 | 43·7 | 325 | 2 | N.N.E. | 64·06 | 111 | 45 | 2,114·4 |

Extreme monthly meteorological records at the Kodaikānal Observatory in 1911.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry bulb thermometer. Highest. | | Dry bulb thermometer. Lowest. | | Wet bulb. Lowest. | | Humidity. Lowest. | | Sun Th. *in vacuo.* Highest. | | Grass therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES | DAY. | INCHES. | DAY. |
| January .. | 22·912 | 5 | 22·730 | 25 | 0·182 | 71·9 | 14 | 43·0 | 26 | 32·0 | 15 | 5 | 15 | 120·6 | 7 | 19·2 | 26 | 603 | 21 | 176 | 3 | 0·17 | 17 |
| February .. | ·970 | 21 | ·770 | 1 | ·200 | 74·2 | 25 | 39·8 | 7 | 31·3 | 7 | 7 | 21 | 132·9 | 10 | 19·3 | 18 | 390 | 27 | 149 | 10 | 0·15 | 5 |
| March .. .. | ·939 | 18 | ·765 | 8 | ·174 | 73·4 | 24 | 46·0 | 2 | 35·2 | 1 | 14 | 28 | 141·3 | 19 | 29·2 | 1 | 489 | 31 | 146 | 7 | 0·06 | 9 |
| April .. .. | ·960 | 21 | 755 | 11 | ·205 | 74·9 | 5 | 51·6 | 28 | 41·1 | 4 | 26 | 4,26 | 138·1 | 4 | 39·5 | 1 | 421 | 9 | 143 | 11 | 1·18 | 7 |
| May .. .. | ·902 | 5 | ·714 | 22 | ·188 | 74·4 | 4 | 50·8 | 28 | 45·0 | 11 | 30 | 13 | 137·2 | 12 | 37·8 | 11 | 456 | 31 | 138 | 20 | 1·69 | 20 |
| June .. .. | ·860 | 15 | ·674 | 10 | ·186 | 67·8 | 16 | 51·9 | 14 | 44·0 | 17 | 51 | 17 | 147·8 | 3 | 44·7 | 3 | 733 | 11 | 121 | 3 | 1·07 | 6 |
| July .. .. | ·868 | 13 | ·658 | 5 | ·210 | 65·8 | 31 | 50·2 | 15 | 43·8 | 31 | 53 | 31 | 142·8 | 10 | 42·9 | 31 | 716 | 19 | 140 | 3 | 1·52 | 2 |
| August .. .. | ·851 | 31 | ·727 | 5,10 | ·124 | 68·4 | 25 | 47·4 | 15 | 39·2 | 13 | 22 | 13 | 148·3 | 1 | 36·2 | 15 | 561 | 7 | 138 | 19 | 0·55 | 21 |
| September .. | ·882 | 15 | ·669 | 23 | ·213 | 68·4 | 7 | 50·5 | 12 | 43·3 | 23 | 40 | 23 | 146·9 | 23 | 39 0 | 14 | 644 | 23 | 159 | 30 | 0·76 | 29 |
| October .. .. | ·916 | 30 | ·735 | 2 | ·181 | 67·8 | 2 | 43·3 | 29 | 39·4 | 28 | 48 | 22 | 141·5 | 2 | 40·3 | 30 | 570 | 4 | 120 | 7 | 3·99 | 18 |
| November .. | .930 | 3 | ·663 | 23 | ·267 | 67·8 | 14 | 45·6 | 28 | 36·2 | 26, 27 | 14 | 26 | 135 0 | 17 | 31·1 | 26 | 883 | 22 | 160 | 8 | 3·17 | 23 |
| December .. | ·912 | 25 | ·759 | 11 | ·153 | 65 3 | 18, 29 | 45·2 | 28 | 36·4 | 30 | 16 | 30 | 127·8 | 8 | 35·2 | 16 | 572 | 13 | 162 | 6 | 1·51 | 7 |

# Appendix III.

KODAIKÁNAL mean hourly wind velocity for the year 1911.

| Month. | Hours. | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| January . | 17 | 17 | 17 | 17 | 17 | 17 | 18 | 19 | 20 | 19 | 19 | 19 | 17 | 15 | 13 | 12 | 9 | 9 | 12 | 12 | 13 | 15 | 16 | 17 |
| February .. | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 6 | 7 | 8 | 9 | 9 | 10 | 11 |
| March .. | 10 | 10 | 10 | 11 | 12 | 12 | 12 | 12 | 15 | 15 | 16 | 16 | 13 | 13 | 12 | 10 | 9 | 9 | 8 | 9 | 9 | 9 | 10 | 11 |
| April .. | 12 | 11 | 12 | 12 | 11 | 11 | 10 | 12 | 14 | 15 | 15 | 14 | 14 | 12 | 12 | 12 | 11 | 11 | 11 | 11 | 11 | 10 | 11 | 12 |
| May .. | 10 | 10 | 10 | 10 | 9 | 9 | 10 | 10 | 10 | 12 | 13 | 12 | 12 | 11 | 12 | 11 | 11 | 11 | 12 | 12 | 10 | 9 | 10 | 10 |
| June .. | 13 | 13 | 13 | 12 | 16 | 15 | 15 | 16 | 15 | 14 | 15 | 14 | 14 | 13 | 14 | 15 | 13 | 15 | 15 | 15 | 15 | 16 | 16 | 16 |
| July .. | 21 | 21 | 20 | 20 | 21 | 19 | 20 | 18 | 19 | 17 | 17 | 18 | 17 | 17 | 16 | 17 | 15 | 17 | 18 | 20 | 21 | 20 | 22 | 22 |
| August .. | 16 | 16 | 17 | 17 | 17 | 16 | 13 | 14 | 14 | 13 | 12 | 13 | 12 | 10 | 11 | 11 | 11 | 12 | 14 | 14 | 15 | 16 | 17 | 17 |
| September .. | 12 | 13 | 13 | 13 | 13 | 13 | 12 | 11 | 11 | 10 | 10 | 10 | 10 | 11 | 11 | 12 | 12 | 10 | 10 | 11 | 11 | 10 | 12 | 12 |
| October .. | 11 | 11 | 11 | 11 | 11 | 12 | 11 | 11 | 12 | 11 | 12 | 12 | 12 | 10 | 11 | 11 | 10 | 9 | 9 | 10 | 11 | 11 | 11 | 13 |
| November .. | 17 | 17 | 17 | 18 | 17 | 17 | 18 | 19 | 13 | 18 | 17 | 17 | 15 | 13 | 13 | 14 | 11 | 12 | 14 | 14 | 15 | 16 | 16 | 17 |
| December .. | 14 | 15 | 15 | 15 | 16 | 15 | 16 | 15 | 16 | 16 | 15 | 15 | 15 | 14 | 13 | 12 | 11 | 12 | 12 | 14 | 15 | 15 | 15 | 16 |
| Mean .. | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 15 | 14 | 15 | 14 | 14 | 12 | 12 | 12 | 11 | 11 | 12 | 12 | 13 | 13 | 14 | 14 |

## Appendix IV.

Kodaikānal Mean Hourly Bright Sunshine for the year 1911.

| Month. | Hours. | | | | | | | | | | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6–7 | 7–8 | 8–9 | 9–10 | 10–11 | 11–12 | 12–13 | 13–14 | 14–15 | 15–16 | 16–17 | 17–18 | |
| January .. .. | 0·08 | 0·71 | 0·77 | 0·84 | 0·83 | 0·88 | 0·91 | 0·89 | 0·81 | 0·68 | 0·57 | 0·07 | |
| February .. .. | ·31 | ·93 | ·98 | ·96 | ·96 | ·89 | ·85 | ·74 | ·72 | ·67 | ·68 | ·39 | |
| March .. .. | ·03 | ·80 | ·99 | ·97 | ·97 | ·84 | ·56 | ·48 | ·45 | ·42 | ·49 | ·24 | |
| April .. .. .. | ·10 | ·76 | ·91 | ·90 | ·92 | ·92 | ·80 | ·62 | ·42 | ·39 | ·32 | ·16 | |
| May .. .. .. | ·26 | ·69 | ·85 | ·90 | ·91 | ·89 | ·78 | ·53 | ·45 | ·25 | ·16 | ·07 | |
| June .. .. .. | ·24 | ·55 | ·60 | ·56 | ·47 | ·43 | ·38 | ·22 | ·22 | ·20 | ·16 | ·02 | |
| July .. .. .. | ·15 | ·35 | ·40 | ·43 | ·44 | ·35 | ·29 | ·22 | ·23 | ·12 | ·05 | ·04 | |
| August .. .. | ·18 | ·71 | ·87 | ·89 | ·84 | ·82 | ·73 | ·64 | ·48 | ·34 | ·29 | ·12 | |
| September .. .. | ·01 | ·52 | ·76 | ·71 | ·62 | ·52 | ·30 | ·25 | ·20 | ·11 | ·09 | ·01 | |
| October .. .. | ·07 | ·42 | ·74 | ·56 | ·52 | ·46 | ·39 | ·28 | ·26 | ·25 | ·16 | ·08 | |
| November .. .. | ·04 | ·44 | ·60 | ·66 | ·58 | ·56 | ·50 | ·38 | ·32 | ·30 | ·24 | ·05 | |
| December .. .. | ·00 | ·32 | ·37 | ·48 | ·55 | ·52 | ·51 | ·53 | ·47 | ·37 | ·28 | ·09 | |
| Mean .. | 0·12 | 0·60 | 0·74 | 0·74 | 0·72 | 0·67 | 0·58 | 0·48 | 0·42 | 0·34 | 0·28 | 0·11 | |

## Appendix V.

Number of days in each month on which the Nilgiris were visible in 1911.

| Month. | Very clear. | Visible. | Just visible. | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January .. .. .. .. | 1 | 14 | 2 | 2 | 19 |
| February .. .. .. .. | .. | 3 | 2 | 6 | 11 |
| March .. .. .. .. | .. | .. | 3 | 1 | 4 |
| April .. .. .. .. | .. | .. | .. | .. | .. |
| May .. .. .. .. .. | .. | 1 | 4 | .. | 5 |
| June .. .. .. .. .. | 4 | 1 | 2 | .. | 7 |
| July .. .. .. .. .. | 4 | 3 | 1 | .. | 8 |
| August .. .. .. .. | 3 | 9 | 7 | .. | 19 |
| September .. .. .. .. | 3 | 9 | 7 | 2 | 21 |
| October .. .. .. .. | 6 | 7 | 3 | .. | 16 |
| November .. .. .. .. | 5 | 8 | .. | .. | 13 |
| December .. .. .. .. | 3 | 7 | .. | 2 | 12 |
| Total .. | 29 | 62 | 31 | 13 | 135 |

# Appendix VI.

MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1911.

| Abnormals of | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure .. .. .. | − 0·034 | + 0·043 | − 0·010 | − 0·026 | − 0·013 | + 0·007 | + 0·008 | − 0·006 | − 0·018 | + 0·037 | + 0·008 | − 0·012 | − 0·002 |
| Temperature of air .. .. .. .. .. | + 1·3 | − 0·4 | + 1·3 | + 0·6 | + 1·1 | + 2·2 | + 2·0 | + 2·3 | + 1·3 | + 1·3 | + 1·7 | + 1·1 | + 1·3 |
| Do. of evaporation .. .. .. | + 1·9 | − 0·8 | + 2·0 | + 1·6 | + 1·4 | + 2·0 | + 1·7 | + 1·6 | + 2·8 | + 1·6 | + 2·5 | + 2·4 | + 1·8 |
| Percentage of humidity .. .. .. .. | + 3 | − 1 | + 3 | + 4 | + 3 | + 1 | + 1 | − 1 | + 6 | + 2 | + 4 | + 6 | + 4 |
| Greatest solar heat *in vacuo* .. .. .. .. | − 4·7 | − 5·3 | − 6·2 | − 5·6 | − 5·3 | − 5·5 | − 4·0 | − 3·8 | − 4·1 | − 3·5 | − 6·6 | − 11·3 | − 5·5 |
| Maximum in shade .. .. .. .. .. | + 1·2 | − 0·3 | + 0·8 | + 0·8 | Same as | + 1·4 | + 2·6 | + 3·4 | + 1·3 | + 1·6 | + 1·0 | − 0·9 | + 1·1 |
| Minimum in shade .. .. .. .. .. | + 0·4 | − 2·3 | + 0·8 | + 0·9 | + 1·2 | + 2·0 | + 1·2 | + 1·6 | + 0·8 | Same as | + 1·6 | + 2·0 | + 0·8 |
| Do. on grass .. .. .. .. .. | + 1·4 | − 1·4 | + 1·9 | + 1·5 | + 1·9 | + 2·9 | + 1·8 | + 2·1 | + 1·8 | + 0·8 | + 2·5 | + 3·7 | + 1·6 |
| Rainfall in inches .. .. .. .. .. | − 0·89 | − 0·28 | − 0·39 | − 0·62 | − 2·11 | − 1·48 | − 2·73 | − 2·40 | + 2·93 | − 5·09 | − 0·52 | + 1·09 | .. |
| Do. since January .. .. .. .. .. | .. | − 1·17 | − 1·56 | − 2·18 | − 4·29 | − 5·77 | − 8·50 | − 10·90 | − 7·97 | − 13·06 | − 13·58 | − 12·49 | − 12·49 |
| General direction of wind .. .. .. .. | 1 point E. | Same as | 2 points S. | 1 point S. | 1 point S. | 1 point W. | 1 point W. | 1 point W. | 2 points W. | 3 points S. | 4 points E. | Same as | 1 point S. |
| Daily velocity in miles .. .. .. .. | − 12 | − 2 | + 12 | + 11 | Same as | − 10 | − 6 | − 12 | − 12 | + 2 | − 31 | + 1 | − 9 |
| Percentage of cloudy sky .. .. .. .. | − 13 | − 9 | − 14 | − 5 | − 18 | − 16 | − 15 | − 8 | − 13 | − 18 | − 13 | + 5 | − 12 |
| Do. of bright sunshine .. .. .. | − 4·6 | − 2·6 | + 0·6 | − 13·3 | − 12·4 | − 6·4 | + 4·4 | − 8·4 | + 1·5 | + 6·8 | − 1·5 | − 17·0 | − 7·4 |

+ Means above normal, — below normal.

# Appendix VII.

**Abstract** of the mean meteorological condition of Madras in the year 1911 compared with the average of past years.

| Mean values of | 1911. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure .. .. .. .. .. .. | 29·862 | 0·002 below. | 29·864 |
| Temperature of air .. .. .. .. .. .. .. | 82·4 | 1·3 above. | 81·1 |
| Do. of evaporation .. .. .. .. .. .. | 76·3 | 1·8 ,, | 74·5 |
| Percentage of humidity .. .. .. .. .. .. | 76 | 4 ,, | 72 |
| Greatest solar heat *in vacuo* . .. .. .. .. .. | 134·2 | 5·5 below. | 139·7 |
| Maximum in shade .. .. .. .. .. . .. | 91·9 | 1·1 above. | 90·8 |
| Minimum in shade .. .. . .. .. . | 75·5 | 0·8 ,, | 74·7 |
| Do. on grass .. .. . .. .. .. | 73·5 | 1·6 ,, | 71·9 |
| Rainfall since January 1st on 76 days . .. .. .. | 36·53 | 12·49 below. | 49·02 |
| General direction of wind .. .. .. .. .. | S.E. by S. | 1 point S. | S.E. |
| Daily velocity in miles .. .. .. .. .. .. .. | 162 | 9 below. | 171 |
| Percentage of cloudy sky .. .. .. .. .. .. | 37 | 12 ,, | 49 |
| Do. of bright sunshine .. .. .. .. .. | 43·6 | 7·4 ,, | 51·0 |

**Duration** and quantity of the wind from different points.

| From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles | From | Hours. | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North .. | 104 | 627 | East .. | 170 | 1,129 | South .. | 292 | 2,337 | West .. | 283 | 2,423 |
| N. by E. .. | 290 | 1,806 | E. by S. .. | 165 | 891 | S. by W. .. | 258 | 1,669 | W. by N. . | 182 | 1,575 |
| N.N.E. .. | 287 | 1,922 | E.S.E. .. | 205 | 1,133 | S.S W. .. | 256 | 1,841 | W.N.W. .. | 166 | 1,503 |
| N.E. by N. | 419 | 2,446 | S.E. by E. | 286 | 1,664 | S.W. by S. | 230 | 1,605 | N.W. by W. | 169 | 1,155 |
| N.E. .. | 317 | 2,361 | S.E. .. | 534 | 3,575 | S.W. .. | 222 | 1,688 | N.W . | 90 | 645 |
| N.E. by E. | 420 | 2,731 | S.E. by S. | 1,064 | 8,323 | S.W. by W. | 214 | 1,439 | N.W. by N. | 56 | 314 |
| E.N.E. .. | 163 | 1,259 | S.S.E. .. | 545 | 4,290 | W.S W. .. | 239 | 1,816 | N.N.W. .. | 83 | 492 |
| E. by N. .. | 236 | 1,235 | S. by E. .. | 254 | 1,825 | W. by S... | 329 | 2,581 | N. by W. | 91 | 493 |

There were 132 calm hours during the year. The resultant corresponding to the above numbers is represented by a south-south-east wind, blowing with a uniform daily velocity of 42 miles.

# Appendix VIII.

Madras Observatory—Number of hours of wind from each point in the year 1911.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. | .. | 13 | 18 | 109 | 75 | 168 | 45 | 66 | 28 | 37 | 31 | 56 | 14 | 40 | 12 | 1 | 1 | 1 | 3 | 1 | 6 | .. | 3 | 2 | 1 | .. | .. | .. | 1 | .. | .. | .. | 12 |
| February .. | 6 | 4 | 2 | 19 | 64 | 114 | 45 | 61 | 27 | 19 | 47 | 49 | 64 | 68 | 9 | 1 | 2 | 2 | 3 | 5 | 4 | 2 | 4 | .. | .. | .. | 1 | 1 | .. | 1 | 2 | 1 | 15 |
| March .. | .. | .. | .. | .. | .. | | .. | .. | .. | .. | .. | 22 | 124 | 366 | 81 | 39 | 25 | 17 | 15 | 23 | 11 | 5 | 1 | 1 | .. | 1 | .. | .. | .. | | .. | .. | 6 |
| April .. | .. | .. | | .. | 2 | .. | 2 | 4 | 16 | 2 | 4 | 1 | 70 | 206 | 175 | 51 | 64 | 40 | 22 | 25 | 16 | 5 | 5 | 4 | 1 | .. | .. | .. | .. | .. | 1 | | 4 |
| May .. .. | .. | .. | 2 | 1 | | 2 | 2 | .. | .. | 3 | 2 | 7 | 35 | 168 | 104 | 74 | 122 | 58 | 32 | 26 | 21 | 10 | 16 | 11 | 9 | 10 | 16 | 6 | 3 | 1 | 3 | .. | .. |
| June .. . | 1 | 2 | 6 | 6 | 4 | 1 | .. | 2 | 6 | 8 | 13 | 18 | 34 | 30 | 31 | 22 | 16 | 27 | 40 | 40 | 57 | 34 | 67 | 88 | 84 | 27 | 27 | 5 | 10 | 6 | 5 | 2 | 1 |
| July .. . | .. | .. | .. | .. | 1 | .. | 3 | 1 | 4 | 6 | 7 | 13 | 28 | 28 | 16 | 21 | 11 | 20 | 28 | 33 | 40 | 81 | 69 | 109 | 79 | 42 | 38 | 49 | 8 | 4 | 3 | .. | 2 |
| August .. | 2 | 1 | 2 | 1 | 4 | 6 | 3 | 4 | 12 | 9 | 26 | 26 | 55 | 33 | 31 | 13 | 13 | 25 | 40 | 34 | 19 | 18 | 34 | 61 | 53 | 55 | 47 | 32 | 37 | 13 | 15 | 3 | 14 |
| September .. | 7 | 2 | 2 | 1 | 1 | 3 | .. | 3 | 11 | 8 | 15 | 45 | 41 | 43 | 51 | 20 | 4 | 34 | 36 | 32 | 26 | 44 | 26 | 37 | 47 | 38 | 35 | 74 | 24 | 15 | 8 | 3 | 14 |
| October .. | 23 | 46 | 50 | 22 | 12 | 11 | 21 | 39 | 30 | 44 | 36 | 11 | 39 | 49 | 32 | 11 | 18 | 33 | 35 | 19 | 22 | 15 | 10 | 11 | 8 | 9 | 1 | 1 | 4 | 3 | 4 | 43 | 32 |
| November .. | 20 | 64 | 44 | 125 | 101 | 72 | 28 | 39 | 19 | 15 | 20 | 38 | 27 | 33 | 3 | 1 | 6 | 1 | 2 | 1 | .. | .. | 2 | 3 | 1 | .. | .. | .. | .. | 1 | 11 | 14 | 29 |
| December . | 45 | 158 | 161 | 135 | 53 | 46 | 14 | 17 | 17 | 14 | 4 | | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 | 2 | .. | .. | 1 | 1 | 3 | 12 | 31 | 25 | 3 |
| Annual total .. | 104 | 290 | 287 | 419 | 317 | 420 | 163 | 236 | 170 | 165 | 205 | 286 | 534 | 1,064 | 545 | 254 | 292 | 258 | 256 | 239 | 222 | 214 | 239 | 329 | 283 | 182 | 166 | 169 | 90 | 56 | 83 | 91 | 132 |

# Appendix IX.

MADRAS OBSERVATORY.—Number of miles of wind from each point in the year 1911.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. .. .. | .. | 86 | 61 | 534 | 473 | 962 | 405 | 404 | 211 | 171 | 162 | 193 | 50 | 173 | 80 | 7 | 6 | 3 | 19 | 8 | 39 | .. | 12 | 7 | 7 | .. | .. | .. | 4 | .. | .. | .. | 4077 |
| February .. .. .. .. | 19 | 32 | 12 | 158 | 407 | 715 | 325 | 245 | 182 | 145 | 185 | 214 | 231 | 301 | 21 | 3 | 19 | 6 | 22 | 35 | 25 | 8 | 18 | .. | .. | .. | 6 | 3 | .. | 2 | 9 | 9 | 3357 |
| March .. .. .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 113 | 696 | 2555 | 769 | 182 | 166 | 106 | 149 | 206 | 82 | 29 | 8 | 10 | .. | 5 | .. | .. | .. | .. | .. | .. | 5076 |
| April .. . .. .. .. | .. | .. | .. | .. | 16 | .. | 8 | 41 | 73 | 5 | 29 | 9 | 687 | 1877 | 1511 | 373 | 584 | 316 | 180 | 122 | 130 | 28 | 24 | 25 | 4 | .. | .. | .. | .. | .. | 7 | .. | 6049 |
| May .. .. .. .. .. | .. | .. | 20 | 6 | .. | 15 | 21 | .. | .. | 24 | 14 | 66 | 373 | 1890 | 1095 | 656 | 992 | 477 | 290 | 242 | 160 | 69 | 119 | 70 | 79 | 100 | 143 | 58 | 24 | 6 | 20 | .. | 7029 |
| June .. . .. .. .. | 10 | 14 | 27 | 28 | 44 | 6 | .. | 12 | 59 | 68 | 105 | 170 | 293 | 266 | 248 | 136 | 94 | 137 | 360 | 331 | 553 | 334 | 616 | 828 | 845 | 285 | 249 | 24 | 81 | 36 | 27 | 25 | 6311 |
| July .. .. .. .. .. | .. | .. | .. | .. | 9 | .. | 18 | 9 | 33 | 61 | 64 | 123 | 215 | 220 | 116 | 142 | 104 | 101 | 186 | 160 | 289 | 545 | 608 | 928 | 693 | 421 | 401 | 351 | 80 | 32 | 29 | .. | 5938 |
| August .. .. .. . | 13 | 7 | 10 | 7 | 25 | 12 | 18 | 9 | 79 | 57 | 159 | 211 | 395 | 201 | 167 | 89 | 110 | 164 | 218 | 163 | 125 | 128 | 231 | 414 | 419 | 436 | 455 | 316 | 252 | 71 | 57 | 14 | 5032 |
| September .. .. .. .. | 31 | 14 | 6 | 7 | 9 | 30 | .. | 23 | 79 | 57 | 105 | 346 | 283 | 324 | 78 | 128 | 79 | 177 | 170 | 191 | 121 | 201 | 125 | 219 | 316 | 284 | 242 | 393 | 159 | 76 | 35 | 16 | 4322 |
| October .. . .. .. | 109 | 250 | 255 | 123 | 66 | 49 | 63 | 169 | 134 | 135 | 154 | 100 | 236 | 352 | 198 | 99 | 146 | 177 | 236 | 144 | 164 | 97 | 41 | 67 | 54 | 44 | 4 | 6 | 18 | 13 | 30 | 157 | 3890 |
| November .. .. .. .. | 93 | 250 | 250 | 628 | 762 | 610 | 258 | 189 | 131 | 89 | 131 | 119 | 116 | 164 | 9 | 10 | 37 | 5 | 11 | 3 | .. | .. | 4 | 8 | 6 | .. | .. | .. | .. | 5 | 41 | 85 | 4014 |
| December . . .. .. | 352 | 1153 | 1281 | 955 | 550 | 332 | 143 | 134 | 148 | 79 | 25 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 10 | 5 | .. | .. | 3 | 4 | 27 | 73 | 237 | 187 | 5698 |
| Annual .. | 627 | 1806 | 1922 | 2446 | 2361 | 2731 | 1259 | 1235 | 1129 | 891 | 1133 | 1664 | 3575 | 8323 | 4290 | 1825 | 2337 | 1669 | 1841 | 1605 | 1688 | 1439 | 1816 | 2581 | 2423 | 1575 | 1503 | 1155 | 645 | 314 | 492 | 493 | 60793 |

# Appendix X.

Madras Observatory.—Number of inches of rain from each point in the year 1911.

| Month. | N | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. | .. | .. | | | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| February .. | | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| March .. | .. | .. | .. | .. | .. | .. | | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| April .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| May .. | .. | | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·01 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| June .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·02 | .. | .. | .. | 0·13 | .. | .. | .. | .. | 0·02 | .. | 0·02 | 0·06 | 0·01 | .. | 0·11 | .. | 0·26 | .. | .. |
| July .. | .. | .. | .. | .. | .. | 0·02 | .. | .. | .. | .. | 0·03 | .. | 0·15 | .. | .. | .. | 0·07 | .. | 0·09 | .. | .. | 0·19 | 0·03 | 0·09 | 0·03 | .. | .. | 0·44 | .. | .. | | | .. |
| August .. | | .. | .. | .. | .. | .. | 0·12 | .. | .. | .. | 0·08 | .. | 0·01 | 0·03 | 0·10 | .. | 0·03 | 0·10 | 0·11 | 0·10 | 0·12 | 0·08 | 0·27 | 0·39 | 0·16 | .. | 0·15 | 0·02 | 0·02 | 0·03 | 0·13 | .. | 0·11 |
| September .. | 0·63 | 0·92 | 0·21 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·18 | .. | 0·90 | .. | 0·60 | 0·03 | .. | 0·11 | 0·35 | 0·49 | 0·84 | .. | .. | 0·11 | 0·30 | 1·68 | 0·22 | 0·03 | .. | .. | 0·02 |
| October .. | 0·66 | .. | 0·29 | .. | .. | 0·07 | 0·15 | 0·17 | 0·60 | 0·08 | 1·02 | .. | 0·03 | .. | 0·14 | .. | .. | .. | .. | .. | 0·09 | .. | .. | .. | 0·06 | 0·01 | .. | .. | 0·99 | 0·41 | 0·62 | 0·52 | .. |
| November .. | 0·17 | 0·80 | 0·34 | 0·12 | 0·12 | 1·15 | 0·52 | 0·03 | 0·68 | 4·25 | 2·08 | 0·07 | 0·47 | 0·54 | .. | .. | .. | .. | 0·18 | 0·02 | .. | .. | 0·03 | 0·02 | .. | | .. | .. | .. | .. | 0·27 | 0·62 | 0·21 |
| December .. | 1·42 | 0·47 | 0·81 | 0·36 | 0·10 | 0·18 | 0·23 | 0·03 | 0·22 | 0·77 | 0·20 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·17 | 0·79 | 0·61 | 0·01 |
| Annual .. | 2·88 | 2·19 | 1·65 | 0·48 | 0·22 | 1·42 | 1·02 | 0·23 | 1·50 | 5·10 | 3·41 | 0·07 | 0·84 | 0·59 | 1·14 | .. | 0·70 | 0·26 | 0·38 | 0·23 | 0·56 | 0·76 | 1·20 | 0·50 | 0·27 | 0·18 | 0·46 | 2·14 | 1·34 | 0·64 | 2·07 | 1·75 | 0·35 |

# Appendix XI.

MADRAS OBSERVATORY.—Wind, cloud and bright sunshine, 1911.

| Month. | Wind resultant. | | Clouds (0—10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H | 16 H. | 20 H. | Mean. | Average per day. | Mean number of hours in a day. |
| | MILES. | | | | | | | HOURS. | HOURS. |
| January .. .. | 105 | E.N.E. | 2·5 | 3·4 | 2·4 | 1·3 | 2·4 | 7·9 | 9·2 |
| February .. .. | 88 | E. by N. | 1·8 | 2·3 | 1·2 | 0·7 | 1·5 | 9·4 | 10·9 |
| March .. .. | 151 | S.S.E. | 1·3 | 1·7 | 0·6 | 0·3 | 1·0 | 9·5 | 10·6 |
| April .. .. | 180 | S.S.E. | 2·5 | 2·0 | 2·8 | 2·3 | 2·4 | 7·4 | 10·6 |
| May .. .. | 180 | S. by E. | 2·2 | 1·8 | 2·2 | 1·0 | 1·8 | 6·1 | 7·9 |
| June .. .. | 122 | S.W. | 4·5 | 4·6 | 5·8 | 4·4 | 4·8 | 4·3 | 8·1 |
| July .. .. | 122 | W.S.W | 5·2 | 4·8 | 6·2 | 6·3 | 5·6 | 4·6 | 9·0 |
| August .. .. | 67 | S.W. by W. | 5·8 | 5·3 | 7·0 | 5·2 | 5·9 | 3·8 | 8·8 |
| September .. .. | 51 | S. W. | 6·0 | 5·3 | 4·9 | 3·5 | 4·9 | 5·2 | 10·7 |
| October .. .. | 34 | S.E. | 3·7 | 4·1 | 4·6 | 3·6 | 4·1 | 6·7 | 10·3 |
| November . .. | 103 | N. E. by E. | 4·2 | 5·7 | 5·6 | 2·7 | 4·6 | 5·3 | 8·8 |
| December .. .. | 164 | N.N.E. | 5·5 | 6·3 | 6·3 | 4·7 | 5·7 | 4·1 | 8·0 |
| Annual .. | 42 | S.S E | 3·8 | 3·9 | 4·1 | 3·0 | 3·7 | 6·2 | — |

# Appendix XII.

## MEAN Monthly and Annual Meteorological Results at the Madras Observatory in 1911.

| — | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer. Mean. | Dry bulb thermometer. Max. | Dry bulb thermometer. Min. | Dry bulb thermometer. Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. By Blanford's tables. | Relative humidity. By Blanford's tables. | Sun Max. *in vac.* | Min. on grass. | Wind. Daily velocity. | Wind. Mean direction. | Wind. Mean direction. | Rain. Amount. | Rain. Days. | Clear sky. | Bright sunshine. | General weather. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | PTS. | POINTS. | INCHES. | NO. | CENTS. | HOURS. | |
| January .. | 29·963 | 0·118 | 76·4 | 85·8 | 67·9 | 17·9 | 71·1 | 67·0 | 0·693 | 76 | 133·7 | 64·5 | 132 | 6 | E.N.E. | .. | .. | 24 | 245·4 | |
| February .. | 30·007 | ·126 | 76·3 | 86·3 | 65·7 | 20·6 | 70·0 | 64·8 | ·651 | 72 | 134·4 | 62·4 | 120 | 8 | E. | .. | .. | 15 | 261·9 | |
| March .. | 29·895 | ·133 | 81·3 | 90·0 | 72·9 | 17·1 | 75·9 | 72·3 | ·816 | 77 | 134·3 | 70·5 | 164 | 14 | S.S.E. | .. | .. | 10 | 295·6 | |
| April .. | ·800 | 130 | 84·6 | 93·7 | 78·1 | 15·6 | 79·2 | 76·6 | ·926 | 78 | 136·1 | 76·2 | 202 | 14 | S.S E. | .. | .. | 24 | 220·5 | |
| May .. | ·722 | ·124 | 87·8 | 97·8 | 82·0 | 15·8 | 79·7 | 77·1 | ·913 | 70 | 137·7 | 80·8 | 227 | 16 | S. | 0·01 | 1 | 18 | 189·2 | |
| June .. | ·710 | ·114 | 88·6 | 99·7 | 82·3 | 17·4 | 79·5 | 75·2 | ·843 | 63 | 135·0 | 78·6 | 210 | 20 | S.W. | 0·63 | 5 | 48 | 128·0 | |
| July .. | ·729 | ·120 | 86·5 | 98·2 | 79·7 | 18·5 | 77·6 | 74·4 | 826 | 66 | 134·7 | 78·4 | 192 | 21 | S.W. by W. | 1·14 | 11 | 56 | 141·3 | |
| August .. | ·744 | ·120 | 85·6 | 97·1 | 78·9 | 18·2 | 77·6 | 74·3 | ·834 | 78 | 136·2 | 77·5 | 162 | 20 | S.W. | 2·16 | 16 | 59 | 118·6 | |
| September . | ·759 | ·136 | 84·3 | 94·5 | 77·9 | 16·6 | 79·1 | 75·6 | ·925 | 78 | 137·2 | 76·8 | 144 | 20 | S.W. | 7·62 | 11 | 49 | 155·8 | |
| October .. | ·878 | ·117 | 81·9 | 90·6 | 75·2 | 15·4 | 77·2 | 74·2 | ·872 | 80 | 135·6 | 73·6 | 125 | 10 | E.S.E. | 5·91 | 9 | 41 | 207·8 | |
| November .. | ·932 | ·111 | 79·2 | 86·0 | 73·9 | 12·1 | 75·4 | 72·8 | ·827 | 86 | 130·8 | 72·0 | 134 | 6 | E.N.E. | 12·69 | 12 | 46 | 159·0 | |
| December .. | ·966 | ·100 | 76·6 | 82·7 | 71·8 | 10·9 | 73·0 | 70·7 | ·762 | 83 | 124·5 | 70·1 | 184 | 2 | N.N.E. | 6·37 | 11 | 57 | 125·8 | |
| Annual .. | 29·841 | 0·120 | 82·4 | 91·9 | 75·5 | 16·3 | 76·3 | 72·9 | 0·824 | 76 | 134·2 | 73·5 | 162 | 13 | S. E. by S. | 36·53 | 76 | 37 | 2,248·9 | |

## EXTREME Monthly Meteorological Records at the Madras Observatory in 1911.

| — | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry bulb thermometer. Highest. | | Dry bulb thermometer. Lowest. | | Wet bulb. Lowest. | | Humidity. Lowest. | | Sun Th. *in vacuo.* Highest. | | Grass therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY. |
| January .. | 30·115 | 5 | 29·763 | 28 | 0·352 | 89·5 | 28 | 63·1 | 30 | 61·9 | 30 | 52 | 13 | 138·1 | 4 | 58·9 | 13 | 251 | 8 | 70 | 23 | .. | .. |
| February .. | ·154 | 12 | ·784 | 1 | ·370 | 92·1 | 1 | 62·0 | 20 | 60·6 | 20 | 46 | 18 | 141·3 | 2 | 58·6 | 20 | 205 | 5 | 78 | 26 | .. | .. |
| March .. | ·030 | 1 | ·746 | 8 | ·284 | 94·9 | 8 | 64·6 | 1 | 64·5 | 1 | 56 | 23 | 142·2 | 14 | 61·5 | 1 | 220 | 9 | 120 | 23 | .. | .. |
| April .. | 29·980 | 21 | ·648 | 29 | ·332 | 102·2 | 18 | 73·3 | 2 | 69·1 | 1 | 50 | 18 | 144·1 | 18 | 70·9 | 2, 3 | 260 | 20 | 116 | 15 | .. | .. |
| May .. | ·875 | 5 | ·570 | 28 | ·305 | 105·5 | 25 | 77·7 | 30 | 72·7 | 16 | 32 | 28 | 144·3 | 20 | 76·4 | 16 | 281 | 10 | 154 | 21 | 0·01 | 29 |
| June .. | ·870 | 15 | ·550 | 10 | ·320 | 106·4 | 1 | 72·6 | 4 | 72·6 | 4 | 33 | 1 | 145·4 | 1 | 72·6 | 4 | 320 | 11 | 123 | 28 | 0·26 | 4 |
| July .. | ·862 | 14 | ·554 | 5 | ·308 | 103·5 | 27, 30 | 74·1 | 10 | 72·7 | 27 | 39 | 26 | 150·5 | 30 | 73·4 | 10 | 268 | 17 | 87 | 3 | 0·45 | 9 |
| August .. | ·845 | 2 | ·619 | 9 | ·226 | 103·7 | 15 | 73·9 | 11 | 69·1 | 6 | 36 | 6 | 148·0 | 15 | 71·7 | 22 | 258 | 5 | 107 | 25 | 0·75 | 30 |
| September .. | ·935 | 15 | ·548 | 24 | ·387 | 100·2 | 3 | 70·6 | 16 | 70·6 | 16 | 45 | 23 | 151·2 | 13 | 70·4 | 16 | 228 | 7 | 61 | 19 | 3·12 | 17 |
| October .. | 30·048 | 30 | ·671 | 1 | ·377 | 99·5 | 7 | 66·7 | 28 | 66·7 | 28 | 46 | 7 | 145·7 | 10 | 63·6 | 6, 7 | 207 | 4 | 67 | 23 | 2·98 | 15 |
| November .. | ·084 | 3 | ·744 | 22 | ·340 | 88·8 | 18 | 69·8 | 13 | 69·1 | 13 | 60 | 13 | 139·1 | 5 | 66·6 | 13 | 247 | 17 | 50 | 26,28 | 4·74 | 21 |
| December .. | ·076 | 25 | ·760 | 3 | ·316 | 86·4 | 1 | 64·4 | 31 | 64·4 | 31 | 62 | 16 | 137·6 | 4 | 61·3 | 31 | 271 | 22 | 105 | 1 | 1·44 | 2 |

# KODAIKANAL AND MADRAS OBSERVATORIES.

## REPORT FOR THE YEAR 1912.

CONTENTS.

# KODAIKANAL AND MADRAS OBSERVATORIES.

## I.—REPORT OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1912.

**Staff.**—The staff of the Observatory on December 31, 1912, was as follows:—

| | |
|---|---|
| Director .. .. .. | J. Evershed. |
| Assistant Director .. .. .. | T. Royds, D.Sc. |
| First Assistant .. .. .. | S. Sitarama Aiyar, B.A. |
| Second Assistant .. .. .. | G. Nagaraja Aiyar. |
| Third Assistant .. .. .. | A. Y. Subrahmanya Aiyar, B.A. |
| Fourth Assistant .. .. .. | S. Balasundaram Aiyar. |
| Writer .. .. .. .. | L. N. Krishnaswamy Aiyar. |
| Photographic Assistant .. .. | R. Krishna Aiyar. |

The subordinate staff consists of a book-binder, an assistant book-binder, a mechanic, five peons, a boy peon for the dark room, and two lascars.

2. **Distribution of work.**—The Director and the Assistant Director have charge of the two spectroheliographs and of the large grating spectrograph. The First, Second, and Third Assistants are in charge of the work with the Cooke equatorial (spectroscopic), the Lerebour and Secretan equatorial (visual and photographic), and the transit instrument. They have also to do the astronomical computing and the preparation of the observations for the press. The Third Assistant has charge of the seismometer and clock comparisons. The Fourth Assistant, with the help of the Writer, is responsible for the whole of the meteorological work. The Writer is responsible for the accounts, correspondence, and all office records. The Photographic Assistant has charge of most of the photographic developing, printing, etc.

3. **Buildings and grounds.**—The electric installation was completed in February and the storage battery received its first charge on the 25th of the month. With the exception of some initial troubles with the gas engine which were soon remedied by Messrs. Siemens, the electric plant has worked satisfactorily throughout the year. The current is used for research work in which an electric arc is required for direct comparisons of metallic and solar spectra. The electric power is also used for pumping water, for lighting, and other minor purposes.

The new quarters for the photographic assistant were completed and occupied in August.

The Takhtasinghji Observatory at Poona was dismantled in February and the instruments were transferred to this observatory by order of the Government of India. The question of constructing a building for locating the 20-inch reflecting telescope is under correspondence with the Government of India and the Public Works Department. Provisional plans for the new building have been prepared by the Director.

The fire lines in the compound have been kept in good order and there was at no time any risk to the buildings and instruments from forest fires.

4. **Instruments.**—The following are the principal instruments belonging to the Observatory, or in use, at the present time:—

Six-inch Cooke equatorial.

Six-inch Lerebour and Secretan equatorial remounted by Grubb, with a five-inch Grubb portrait lens attached. The Lerebour and Secretan object glass has been replaced by a Cooke photo-visual lens of the same aperture and the instrument has been adapted for direct solar photography in addition to visual work.

Spectrograph I.—consisting of slit, collimator lenses of 4 and 7 feet focus, 2-inch parabolic grating, and camera tube without lens. Used in connection with an 11-inch polar siderostat and 6-inch Grubb lens of 40 feet focus.

Spectrograph II.—consisting of a collimator of 7 feet focus and camera of 14 fee focus placed at an angle of 60° with the former. Plane gratings of $3\frac{1}{4}$ inches or 5 inches ruled surface are used, and the slit is provided with various devices for the direct comparison of spectra from different sources, and for rotating the solar image.
Spectroheliograph—with 18-inch siderostat and 12-inch Cooke photo-visual lens of 20 feet focus, by the Cambridge Scientific Instrument Company.
An auxiliary spectroheliograph attached to the above, made in the Observatory workshop.
Six-inch transit instrument and barrel chronograph, formerly the property of the Survey of India.
Theodolite, six-inch—Cooke.
Sextant.
Evershed spectroscope with three prisms, for prominence and sunspot work, by Hilger.
Mean time clock, Kullberg 6326.
Do. Shelton.
Mean time chronometer, Kullberg 6299.
Sidereal chronometer, Kullberg 6134.
Tape chronograph, Fuess.
Two micrometers for measuring spectrum photographs, Hilger.
Dividing engine, Cambridge Scientific Instrument Company, Limited.
Milne horizontal pendulum seismograph.
Induction coil with necessary adjuncts.
Small polar siderostat.
Universal instrument.
Complete set of meteorological instruments, including Richard barograph and thermograph, and wind recorders.
A high class screw cutting turning lathe by Messrs. Cooke & Sons.
Angström Pyrheliometer.
An 18-inch concave mirror by Henry of Paris belonging to the Director is mounted in the spectroheliograph room for general spectrum work.

The instruments received from the Takhtasinghji Observatory at Poona include the following :—

Twenty-inch reflecting telescope, by Common.
Six-inch Cooke photo-visual telescope with equatorial mounting.
Two prisms of 6 inches aperture for use with the above.
Twelve-inch Cooke siderostat.
Eight-inch horizontal telescope.
Large grating spectroscope, by Hilger.
An ultra-violet spectrograph by Grubb.

## OBSERVATIONS.

### (a) Solar Physics.

5. The following table shows for each day the solar observations that were made :—

# Table A.

## Solar Observations in 1912.

A = Spots observed. B = Spot spectrum observed. C = Prominences observed. D = Photoheliograms taken. E = Spectroheliograms taken.

| Dates. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 .. | A—CDE | A—CDE | A——DE | ——CDE | ——*C*DE | A—CDE | A—*C*DE | A—*C*DE | A—CDE | A—CDE | A—CDE | A———— |
| 2 .. | A—CDE | A—*C*DE | A—CDE | ——*C*DE | ——CDE | A—*C*DE | A—CDE | A——D*E* | A—CDE | A—*C*DE | A—CDE | A—*C*DE |
| 3 .. | A—*C*DE | A—CDE | A—CDE | ——*C*DE | ——CDE | A—CDE | A—CDE | A—*C*DE | A—CDE | A—*C*DE | A—CDE | ————— |
| 4 .. | A—CDE | A—CDE | A—CDE | ———D*E* | ——CDE | A—*C*DE | A—CDE | A—*C*DE | ——*C*D*E* | A—*C*DE | A—CDE | A———*E* |
| 5 .. | A—CDE | A—*C*DE | A—*C*DE | ——CDE | ——CDE | A—*C*DE | A——D*E* | A—CDE | A——DE | A—*C*DE | A—CDE | A—CDE |
| 6 .. | A—CDE | A—CDE | A—*C*DE | ———D*E* | ——CDE | ————*E* | A—*C*D*E* | A—CDE | A—*C*DE | A——D*E* | A—CDE | A—CDE |
| 7 .. | A—CDE | A—CDE | A——DE | ——CDE | ——*C*DE | A—CDE | ————— | A—*C*DE | A—CDE | ————— | A—CDE | A—CDE |
| 8 .. | A—CDE | A—CDE | ——CDE | ——CDE | ——CDE | A—CDE | A——DE | A——DE | A—*C*D*E* | A——DE | A——D*E* | A—CDE |
| 9 .. | A—CDE | A—CDE | ——CDE | ——CDE | ——*C*DE | ——*C*D*E* | A—CDE | ————— | A—*C*DE | A——DE | A——D*E* | A—CDE |
| 10 .. | A—CDE | A—CDE | ——CDE | ——CDE | ——CDE | ————— | A——D*E* | A—*C*DE | A—*C*DE | A——DE | A—CDE | A—CDE |
| 11 .. | A—CDE | A—CDE | A—CDE | ——CDE | ——CDE | A—*C*D*E* | A—CDE | A—*C*DE | A—CDE | A——DE | A—CDE | A—*C*DE |
| 12 .. | A—CDE | A—CD*E* | A—CDE | —B*C*DE | ——CDE | A——D*E* | A——D*E* | A——D*E* | A—CDE | A——DE | A—CDE | A—*C*DE |
| 13 .. | A—CDE | A—*C*DE | ABCDE | ——CDE | ——*C*DE | ——*C*D*E* | ————*E* | A——D*E* | ————*E* | A——DE | A—CDE | ————— |
| 14 .. | A—*C*DE | A—CDE | ABCDE | ——*C*DE | ——CDE | ———DE | A—*C*DE | A—*C*D*E* | A—CDE | ———D*E* | A——D*E* | ————— |
| 15 .. | — | A—CDE | A—CDE | ——CDE | ——CDE | ———D— | A——D*E* | A—*C*D*E* | A—CDE | A—CDE | A—CD*E* | A—CDE |
| 16 .. | A—*C*DE | A—CDE | A—CDE | ——CDE | A—CDE | ———D*E* | A—*C*DE | A—CDE | A——D*E* | A——D*E* | ————— | A—CDE |
| 17 .. | A—CDE | A—CDE | A—CDE | ——CDE | A—*C*DE | ——*C*DE | A—*C*DE | A—*C*DE | ————— | A—*C*DE | ————— | A—*C*DE |
| 18 .. | A—CDE | A—CDE | A—*C*DE | ——*C*DE | A—*C*DE | ———D*E* | A—*C*DE | A—CDE | A—CDE | ————— | A——D*E* | ————— |
| 19 .. | A—CDE | A—CDE | A—CDE | ——CDE | A—*C*DE | A—*C*DE | A—CDE | A—*C*DE | A—CDE | ————— | ————— | ————— |
| 20 .. | A—CDE | A—CDE | A—*C*DE | ——CDE | A—CDE | ———DE | A———— | A——D*E* | A—CD*E* | ————— | ————— | A—CDE |
| 21 .. | A—CDE | A—*C*DE | ——*C*D*E* | ——CDE | A—*C*DE | ——*C*D*E* | ————— | ——*C*D*E* | A—*C*DE | A——D*E* | A——D— | A—CDE |
| 22 .. | A—CDE | A—CDE | ——CDE | ——*C*DE | A—*C*DE | A—*C*DE | A——DE | A—*C*DE | A—*C*DE | A—*C*DE | A—CD*E* | A—CDE |
| 23 .. | A—CDE | A—CDE | ——CDE | ——CDE | A—CDE | A—*C*DE | ————— | A—CDE | A—CDE | A——D*E* | A—CDE | A—CDE |
| 24 .. | A—CDE | A—CDE | ——*C*DE | ——CDE | A—CDE | A——DE | ————*E* | ——*C*D*E* | A—CDE | A——D*E* | A—CDE | A—CDE |
| 25 .. | A—CDE | A—CDE | ——CDE | ——*C*D*E* | A—*C*DE | ————— | ————— | ————— | A—*C*DE | A—CDE | A——D*E* | A—CDE |
| 26 .. | A—CDE | A—CDE | ——CDE | ——CDE | A—CDE | A——DE | A—*C*D*E* | A——D— | A——D*E* | A——DE | A———*E* | A—*C*DE |
| 27 .. | A—CDE | A—CDE | ——CDE | ——CDE | A—CDE | A——D— | ————— | ——*C*DE | A—CDE | A—*C*D*E* | A—CDE | A—*C*DE |
| 28 .. | A—CDE | A—CDE | ——CDE | ——*C*DE | A—*C*DE | A—*C*DE | A———— | A—CDE | A—*C*DE | A—CDE | ————— | A—CDE |
| 29 .. | A—CDE | A—CDE | ——CDE | ——CDE | A—CDE | A—*C*DE | A—*C*DE | A——D*E* | A—*C*DE | ————— | ————— | A—CDE |
| 30 .. | A—CDE | | ——*C*DE | ——CDE | A—*C*DE | A—CDE | A——DE | A—*C*DE | A—CDE | A—CDE | ————— | A—CDE |
| 31 .. | A—CDE | | ——CDE | | A—CDE | | A—CDE | A—CDE | | A—CDE | | A—CDE |

*Note.*—When a letter is in italics, it means that on that day the observations were not complete.

SOLAR Observations—Abstract.

| — | 1912. January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 30 | 29 | 17 | .. | 16 | 18 | 24 | 26 | 27 | 25 | 23 | 26 | 261 |
| B | .. | .. | 2 | 1 | .. | .. | . | .. | .. | .. | .. | .. | 3 |
| C | 30 | 29 | 29 | 28 | 31 | 18 | 15 | 22 | 25 | 13 | 16 | 24 | 280 |
| D | 30 | 29 | 31 | 30 | 31 | 27 | 22 | 29 | 28 | 26 | 22 | 24 | 329 |
| E | 30 | 29 | 31 | 30 | 31 | 26 | 24 | 28 | 29 | 26 | 22 | 25 | 331 |

The sun's disc was examined visually for spots etc. on 261 days only whilst in 1911 it was examined on 333 days. The reduction in the number of observations was mainly due to an interruption of 66 days whilst the Lerebour and Secretan telescope was being adapted for both visual and photographic work. The observing conditions were perhaps not so good as in 1911 and there were as many as 25 days when there was no sunshine recorded.

6. **Photoheliograph**.—Photographs of the sun were obtained on 329 days as against 324 in 1911. Up to July 31 they were taken with the Dallmeyer photoheliograph, and since that date mostly with the Lerebour and Secretan telescope. Double exposures are taken twice a month for determining the error of orientation of the photographs. Two solar negatives were sent to the Greenwich Observatory out of three asked for to complete the series.

7. **Spectroheliograph**.—Monochromatic photographs of the sun's disc in "K" light were taken on 331 days, and prominence plates on 280 days. With the auto-collimating spectroheliograph H $\alpha$ images were secured on 158 days. The prominence plates are measured as soon as obtained, and the results tabulated. Duplicates of the disc plates have been sent to South Kensington for measurement, as in former years, and in exchange prominence plates have been received from South Kensington.

Mr. Royds has made a special study of the absorption markings shown on the H $\alpha$ plates.

8. **Grating Spectrograph**.—Owing to the paucity of sunspots only a few spectra were obtained for the study of radial movements. The general state of calm in the solar atmosphere was, however, specially favourable for other lines of research and a large number of comparison spectra were obtained of the sun's limb and the centre of the disc. The relative displacements of the lines towards the red at the limb have been measured and compared with the displacements due to pressure. A series of plates has also been obtained of the arc spectrum of iron in air and the centre of the sun's disc. These have been measured to determine the general displacement of the solar lines after correction for the earth's movements. The general result of the whole investigation, although far from being completed, appears to throw great doubt on the usual interpretation of the line displacements, which ascribes the general shift of the solar lines, as well as the relative shift of the lines at the limb, to the effect of pressure. The investigation is being continued with the aid of a special device for the direct photographic comparison of the solar and arc spectra, and a second series of plates has been obtained with the arc under reduced pressure.

9. **6-inch Cooke Equatorial and Spectroscope**.—Visual observations of the prominences and of spot spectra have been continued as in former years but only two spots were studied in detail in this way, Nos. 6977 and 6980 of the Greenwhich numeration. Observation of the behaviour of the C and $D_3$ lines were recorded in four spots.

In October the telescope and its mounting were removed from the south dome and re-erected in the photoheliograph dome. This involved a break in the prominence observations of one week only. Prominences were recorded visually on 280 days.

10. **Poona 6-inch Equatorial.**—This fine instrument has been erected in the south dome and a powerful grating spectroscope, also from Poona, has been adapted for use with it.

It is intended to make a special study of the metallic prominences and of prominences showing displacements of the hydrogen lines It has been found from the Kodaikanal records that not only do prominences in general show a numerical preponderance on the east limb, but the preponderance is much greater in the above mentioned special classes of prominence. As the metallic prominences are closely associated with sun-spots, this appears to indicate that both prominences and spots are more active when on the east limb than when on the west. There is also found to be an excess of displacements of the hydrogen lines towards the red end of the spectrum. These facts raise questions which will require the most careful study in the future, and the Poona telescope is well adapted for this work.

11. **Solar Radiation.**—The new photographic telescope for comparing the intensity of moonlight and first type stars was completed during the year, but owing to cloudy skies no opportunity for using it occurred until December when a few plates were secured.

A Hartmann Photometer for measuring the plates has been received from Messrs. Toepfer

*Summary of Sunspot and Prominence Observations.*

12. **Sun-spots.**—The following table shows the monthly numbers of new groups observed, the mean daily numbers of spots visible, and the distribution between the northern and southern hemispheres :—

| — | January. | February. | March. | April | May | June | July | August | September. | October | November | December | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups .. .. | . | .. | 1 | 2 | 2 | 1 | 3 | 2 | 5 | 1 | 1 | 4 | 22 |
| Daily number .. . | | .. | 0 4 | 0·3 | 0·4 | 0·5 | 0·3 | 0 1 | 0 7 | 0 3 | | 0 4 | 0·3 |
| North .. .. | | .. | .. | .. | .. | .. | . | .. | .. | .. | .. | 2 | 2 |
| South .. .. . | .. | . | 1 | 2 | 2 | 1 | 3 | 2 | 5 | 1 | 1 | 1 | 19 |
| Equator . . | .. | .. | . | | .. | .. | .. | .. | . | .. | . | 1 | 1 |

The decline in spot activity noted in the last few years continued in 1912, but the rate of decrease between 1911 and 1912 has lessened very slightly as is shown in the following comparisons for the four years 1909–1912.

| Year. | Number of new groups. | Per cent of previous years number |
|---|---|---|
| 1909 .. .. .. .. .. .. .. .. | 220 | .. |
| 1910 .. .. .. .. .. .. .. .. | 152 | 68 |
| 1911 .. .. .. .. .. .. .. .. | 56 | 37 |
| 1912 .. .. .. .. .. .. .. .. | 22 | 39 |

| Year | Mean daily numbers. | Per cent. of previous years number. |
|---|---|---|
| 1909 .. .. .. .. .. .. .. .. | 3·9 | .. |
| 1910 .. .. .. .. .. .. .. .. | 1·8 | 46 |
| 1911 .. .. .. .. .. .. .. .. | 0·7 | 39 |
| 1912 .. .. .. .. .. .. .. .. | 0·3 | 43 |

| Year. | Number of days on which no spot was seen. | Ratio of increase over previous year. |
|---|---|---|
| 1909 .. .. .. .. .. .. .. .. | 5 | .. |
| 1910 .. .. .. .. .. .. .. .. | 56 | 11·2 |
| 1911 .. .. .. .. .. .. .. .. | 158 | 2·8 |
| 1912 .. .. .. .. .. .. .. .. | 240 | 1·5 |

It seems probable that the minimum of spot activity occurred during the early part of 1912, not a single spot having been recorded in January and February, whilst there was a slight recovery of activity in September and in December. The appearance of a spot in latitude + 27° in December may probably be considered as the beginning of a new cycle of activity.

Of the twenty-two groups recorded during the year, nineteen were in the southern hemisphere and were, on the whole, closer to the equator than in 1911. Their mean latitude was—7°·2 against—9°·8 in 1911. Of the three remaining spots, one was a small dot on the equator, one was at + 20° and the third, the last group of the year was at + 27°; all three spots were observed in the latter part of December

Only four groups—No. 2007 (March 7 to 19), No. 2012 (June 17 to 28), No. 2023 (October 4 to 11), and No. 2025 (December 15 to 23)—contained fairly large spots. The spectra of Nos. 2007, 2008 (April), 2021 (September), and 2025 (December) showed disturbances in C and $D_3$

13. **Prominences**.—The mean areas of prominences for each hemisphere of the sun are shown in the following table in which the figures for the previous two years are given for comparison :—

*Mean daily profile areas of Prominences in square minutes of arc*

| — | 1910 | 1911 | 1912. |
|---|---|---|---|
| North .. .. .. | 2·03 | 1 27 | 0 95 |
| South .. .. .. | 2 07 | 1·64 | 1·51 |
| Total .. | 4·10 | 2·91 | 2·46 |

The reduction of prominence area is here shown to be very much less than the reduction of spot numbers or of new groups, also the rate of decrease has lessened considerably between 1911 and 1912.

The area curve underwent a marked change in the second-half of 1911. There were several sharp, though small, maxima and a pronounced maximum near 50° south. These features were maintained in a general way in 1912.

*Metallic Prominences*

| — | Number observed | Mean latitude. | Extreme latitudes |
|---|---|---|---|
| North .. .. .. | 3 | 14° 5 | 1°·5 35° |
| South .. .. .. | 9 | 18° 0 | 8° 46°·5 |

The prominence activity in each month may be estimated from the following table :—

*Number of Prominences.*

| Months. | Prominences—one minute or more in height | Metallic. | Eruptive |
|---|---|---|---|
| January .. .. .. .. | 84 | 1 | 4 |
| February .. .. .. .. | 63 | 1 | 3 |
| March .. .. .. .. | 63 | 3 | 4 |
| April .. .. .. .. | 39 | 1 | 6 |
| May .. .. .. .. | 32 | .. | 1 |
| June .. .. .. | 24 | 2 | .. |
| July .. .. .. .. | 16 | 1 | 5 |
| August .. .. .. .. | 42 | .. | 2 |
| September .. .. .. .. | 34 | 1 | 1 |
| October .. .. .. .. | 31 | .. | . |
| November .. .. .. .. | 33 | 2 | 3 |
| December .. .. .. .. | 58 | .. | 3 |

The metallic and eruptive prominences show a decrease corresponding to that of the spot activity. But there is actually an increase in the number of "large" prominences; this is particularly striking in January and February when there was no spot recorded, but the numbers of large prominences are the highest in the year.

The following were the more noteworthy prominences observed during the year:—

*June.*—A prominence recorded at latitude—25° East on the 22nd reached a height of 200″ at $10^h\ 31^m$ but fell to 130″ at $11^h\ 20^m$.

*July.*—A metallic prominence was observed at + 78° West on the 31st.

*August.*—A large prominence covering 30° of the south-west limb was photographed on the 31st and was slowly rising without altering its general shape. The height reached was 170″ at $10^h\ 17^m$.

*September.*—A prominence photographed at latitude—33° East on the 30th attained a height of 240″.

*November.*—A prominence photographed at latitude—18° West on the 12th was 240″ in height.

(*b*) Other Observations.

14. **Time.**—The error of the standard clock is usually determined by reference to the $16^h$ signal from the Madras Observatory. This is rendered possible by the courtesy of the Telegraph department which permits the Madras wire to be joined through to this observatory. The signal is received with accuracy on most days and all failures are at once reported to the officer in charge of the Trichinopoly division. Time determinations are made with the transit instrument, when necessary, as a check.

15. **Meteorology.**—Meteorological observations were carried on as in former years. Eye observations are made at $8^h$, $10^h$ and $16^h$ local mean time. Temperatures and pressures are recorded continuously by a Richard thermograph (wet and dry bulb) and barograph, and the mean temperatures and pressures are obtained from the traces, corrected by reference to the eye observations. The wind direction and velocity shown in tables II and III of the appendix are obtained from a Beckley anemograph, and the $8^h$ values for the daily weather reports of Simla and Madras from a Robinson anemometer and a wind vane.

*Pressure.*—The average pressure for the year was 0·007 inch above the normal. The monthly mean was below normal during four months only—June, July, August and November—and the greatest defect was only 0·009 inch. The greatest excess, on the other hand, was 0·034 inch in April.

*Temperature.*—The monthly mean temperature was in excess throughout the year, so also were the monthly mean maxima during nine months of the year, the annual excess in the two cases being 0°·9 and 1°·2, respectively. The annual means of the other temperature records, viz., "dry minimum", "wet mean", "wet minimum", "sun maximum", and "grass minimum" were also higher than the normal.

*Humidity.*—The mean humidity for the year was the same as the normal, viz., 74 per cent. There was a defect of 15 per cent. in January, but the other months did not differ greatly from the normal.

*Rainfall.*—The rainfall distribution was rather abnormal. There was a deficiency in the months of January, February, March, July, August and October amounting to 7·44 inches, and an excess in the other months amounting to 13·12 inches, the total excess above normal being 5·68 inches. The most striking deviations were a defect of 2·52 inches in January and excesses of 5·77 inches in April and 5·24 inches in November.

*Wind.*—There was a defect of 95 miles in September and an excess of 92 miles in December in the average daily wind velocity, but there was otherwise no striking difference from the normal. The mean daily velocity was only 3 miles in defect. The mean wind direction for the year was north-north-east, the normal direction being north.

*Transparency of the atmosphere.*—The transparency of the lower atmosphere as judged by the visibility of the Nilgiris, about 100 miles distant, was much below normal as was the case also in 1911. The atmosphere was clearest in January and December and least clear in April.

*Cloud and Sunshine.*—The year as a whole was somewhat more cloudy than usual and there were 25 days when no sunshine was recorded. The total number of hours of bright sunshine was 1997, which is 30·8 hours below the average of eleven years.

16. **Seismology.**—The Milne horizontal pendulum recorded 81 earthquakes during the year as against 95 in 1911. The highest records were in May and June, with 13 and 16 respectively. The heaviest shock, as judged by duration and amplitude, was due to the Burma earthquake of the 29th May.

17. **Library.**—One hundred and sixty-four volumes were bound during the year.

18. **Publications.**—Bulletins Nos. XXV. and XXVI. dealing with the prominence observations for 1911 were published during the year and Nos. XXVII., XXVIII. and XXIX. were sent to the press towards the end of the year. The titles of these are "On the presence of Radium and the elements of the inactive group in the chromosphere", "On the relative numbers of prominences observed on the eastern and western limbs" and "Summary of prominence observations for the first-half of 1912".

19. **General.**—The Officiating Director-General of Observatories inspected the Kodaikanal Observatory in February and the Director inspected the Madras Observatory in October.

The staff of the Observatory worked well during the year.

J. EVERSHED,
*Director, Kodaikanal and Madras Observatories.*

THE OBSERVATORY, KODAIKANAL,
31*st January* 1913.

## II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1912.

**Staff.**—The staff at the Observatory on December 31, 1912, was as follows :—

| | |
|---|---|
| Deputy Director .. .. .. | R. Ll. Jones. |
| Computer .. .. .. .. | S. Solomon Pillai. |
| First assistant .. .. .. .. | A. A. Narayana Aiyar, B.A. |
| Second assistant .. .. .. | E. Ramanujam Pillai. |

Two peons and two lascars form the subordinate staff. The Computer was on privilege leave from 12th April to 31st May, and the First Assistant from 16th July to 15th August.

2. **Time Service.**—Time determinations have been made systematically on the plan followed in previous years and the time service was efficiently maintained. By the Adjutant-General's order the firing of the 8 P.M. gun at the Fort was discontinued from the 29th January. Towards the end of the year intimation was received that the 8 P.M. firing was to be resumed from the 1st January 1913. No other change was made in the number or manner of the signals distributed from the observatory. The Fort gun failed on five occasions and fired correctly on 386 occasions out of 391, giving 98·7 as the percentage of success. The failures were due to faults outside the observatory.

The Semaphore at the Port office failed on one occasion and was dropped correctly at 1 P.M. every other day ; on the day it failed at 1 P.M. it was dropped correctly at 2 P.M.

3. **Meteorological Observations.**—In addition to the ordinary meteorological observations, extra observations were taken for storm warning purposes and telegrams sent to Simla on two occasions and to Calcutta on 107 occasions. A new Thermograph was received from Calcutta and brought into use on the 15th May 1912.

4. **Buildings.**—In addition to the usual annual repairs to the office and quarters, special repairs in the quarters were carried out during the year. The porch which was condemned early in the year was pulled down and rebuilt and malthoid sheeting was laid on the roof so that the quarters are now rain-proof. The Executive Engineer proposed to investigate the foundations of the transit circle in order to try and discover the cause of the large changes in level which have occurred during the last three years ; but action was deferred till after the next inspection by the Director-General of Observatories.

5. **Instruments.**—The following is a list of the instruments at the observatory on the 31st December 1912 :—

(*a*) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton & Simms.
Sidereal Clock—Haswall.
,, Dent, No. 1408.
,, S. Riefler, No. 61.
Mean Time Clock—J. H. Agar Baugh, No. 105.
,, with galvanometer—Shepherd & Sons.
Meridian Circle—Troughton & Simms.
Mean Time Chronometer—V. Kullberg, No. 5394.
,, ,, No. 6544.
Portable Transit Instrument—Dollond.
Portable Telescope with stand.
Tape Chronograph—R. Fuess.
Relay for use with the Chronograph—Siemens.

(*b*) *Meteorological.*

Richard's Barograph—No. 10, L. Casella.
,, Thermograph—No. 29637, L. Casella.
Beckley's Anemograph—Adie.
Sunshine Recorder—No. 149, L. Casella.
Nephoscope—Mons Jules Daboseq & Ph. Pellin.
Barometer, Fortin's—No. 1771, L. Casella.
,, No. 725, L. Casella (spare).
,, No. 1420, L. Casella (spare).

Dry Bulb Thermometer—No. 94221, L. Casella.
„ No. 38037, Negretti & Zambra (spare).
Wet Bulb Thermometer—No. 94219, L. Casella.
„ No. 38037, Negretti & Zambra (spare).
Dry Maximum Thermometer—No. 8581, Negretti & Zambra.
Dry Minimum Thermometer—No. 69017, L. Casella.
Wet Minimum Thermometer—No. 91753, Negretti & Zambra.
Sun Maximum Thermometer—No. 10479, Negretti & Zambra.
Grass Minimum Thermometer—No. 3377, Negretti & Zambra.
Raingauge (8″ diameter)—No. 1042, Negretti and Zambra.
Measure glass for above.
Raingauge (5″ diameter).
Measure glass for above.

In its rainfall distribution the year was similar to the previous one. The first nine months were very dry—August excepted. During this time a steady and progressive change in the level of the transit circle took place from a small positive value at the beginning of the year to a large negative value in October. With the heavy rain in October and November the level changed rapidly to a small negative value and has remained almost constant since. The steady change during the first nine months suffered a slight check in August after a moderate fall of rain. With the dry weather however which followed, the change was resumed; the error reached its maximum in October. The azimuth was not much affected while these changes in level were going on. The observations for time were on the whole satisfactory and the rate of the Riefler clock has been very steady throughout the year, except for a short period of about ten days at the end of July and the beginning of August.

It is difficult to surmise the cause of these large annual changes in level which have been so prominent since 1910. According to the account given on pages V and VI in Volume I of "Madras Meridian Circle Observations, 1862, 1863 and 1864" the piers of the transit circle rest on the eastern end of a "solid pyramidal mass of masonry, 37 feet long by 6 feet wide at its upper surface, 6 feet in depth and 45 feet long by 12 feet broad below. A conical granite pier rests on the centre of this mass, 4 feet in diameter at its base tapering up to 2 feet at its total height of 18 feet and weighing certainly over ten tons." It is difficult to believe that the whole of this mass which is described as "probably little less firm or massive than a solid rock of similar dimensions" partakes as a rigid body of the movement revealed by the level observations. It is more probable that owing to local subsidences in the soil, the masonry bar has broken and that the transit instrument is on the smaller part of it. There is ample evidence of subsidences at the surface of the ground in the compound to the south of the observatory.

The transit instrument was overhauled during the visit of the Director in October and the collimators were taken down and readjusted. A specification for a new eye-piece to the transit was drawn up at the same time.

6. **Weather Summary.**—The following is a summary, in the usual form, of the meteorological conditions at Madras during 1912:—

*Pressure.*—Pressure was above normal in January, April, May, October and December and below normal in the remaining months. The greatest excess was 0·051 inch in April and the greatest defect 0·031 inch in August. The highest pressure recorded was 30·184 inches on January 19th and the lowest 29·522 inches on July 28th.

*Temperature.*—The mean temperature of air was about normal in all months except in January and December. The highest shade temperature recorded was 111°·6F. on May 19th and the lowest 60°·5F. on January 4th. The highest temperature in the sun was 149°·2F. on September 16th and the lowest on grass was 54°·9F. on January 10th.

*Humidity.*—Humidity was above normal almost throughout the year.

*Wind.*—The wind direction was normal in April, July and December. It was more southerly than usual in February, June and September, more northerly in October and more easterly in November. The wind velocity was apparently below

normal in all the months except March. In July, the mean daily velocity was 43 miles below average. There is no doubt however that a change in exposure accounts in part for the low velocities relative to the average.

*Cloud.*—The percentage of cloud was normal in March, above normal in July and August and below normal in the remaining months.

*Sunshine.*—The percentage of bright sunshine was above normal in March, April, June, September and December and below normal in the other months.

*Rainfall.*—The rainfall was above the average in January, August and November, normal in October and below normal during the other months; the greatest excess being 8·60 inches in November and the greatest defect 4·98 inches in December. The total fall for the year was 46·69 inches against an average of 49·02 inches. The monsoon rainfall from October 15 to the end of the year was 32·70 inches against an average of 26·00 inches. The heaviest fall on any day was 4·05 inches on November 13.

MADRAS OBSERVATORY,
*28th January* 1913.

R. LL. JONES,
*Deputy Director.*

# Appendix I.

## Kodaikanal Observatory Seismological Records.

| No. | Date. | | P.T. commence G.M.T. | | L.W. commence G.M.T. | | Maxima G.M.T. | | End G.M.T. | | Duration G.M.T. | | Max. Amp. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1912. | | H. | M. | H. | M. | H. | M. | H. | M. | H. | M. | MM. " | |
| 1 | Jan. | 4 .. | 4 | 07·4 | 4 | 12·3 | 4 | 15·1 | 4 | 30·0 | 0 | 22·6 | 0·8 = 0·3 | |
| 2 | | 4 .. | 16 | 09·9 | 16 | 40·7 | 16 | 44·0 | 18 | 29·5 | 2 | 19·6 | 1·1 = 0·4 | |
| 3 | | 20 .. | 4 | 22·3 | | .. | | .. | 4 | 48·0 ? | 0 | 25·7 | .. | Widening of line. Instrument examined at 4h. 48m. |
| 4 | | 26 .. | 14 | 52·4 | 14 | 57·7 | 14 | 58·2 | 15 | 25·9 | 0 | 33·5 | 0·7 = 0·3 | |
| 5 | | 31 .. | 13 | 33·9 | | .. | | .. | 13 | 45·0 | 0 | 11·1 | .. | Widening of line. |
| 6 | | 31 .. | 20 | 44·0 | 21 | 08·5<br>14·4 | 21 | 21·1 | 21 | 47·9 | 1 | 03·9 | 1·0 = 0·4 | |
| 7 | Feb. | 13 .. | 17 | 16·7 | | .. | | .. | 17 | 30·0 | 0 | 13·3 | .. | Do. |
| 8 | | 16 .. | 10 | 00·3 | 10 | 19·1 | 10 | 19·3 | 10 | 35·4 | 0 | 35·9 | 0·6 = 0·3 | |
| 9 | March | 11 .. | 11 | 23·1 | | .. | | .. | 12 | 19·0 | 0 | 55·9 | .. | Do. |
| 10 | | 11 .. | 16 | 01·8 | | .. | | .. | 16 | 12·0 | 0 | 10·2 | .. | Do. |
| 11 | | 17 .. | | ? | 7 | 31·2 | 7 | 31·5 | 7 | 39·7 | 0 | 08·5 | 0·8 = 0·4 | Hour signal at 7h. 30m. |
| 12 | | 24 .. | 12 | 28·3 | | .. | 12<br>12 | 30·6<br>32·0 | 12 | 47·4 | 0 | 19·1 | 0·8 = 0·3<br>0·7 = 0·3 | |
| 13 | April | 11 .. | 5 | 54·8 | | .. | | .. | 6 | 20·0 | 0 | 25·2 | .. | Widening of line. |
| 14 | | 11 . | 10 | 14·6 | 10 | 14·9 | 10 | 15·1 | 10 | 28·5 | 0 | 13·9 | 0·6 = 0·3 | |
| 15 | | 20 .. | 2 | 11·0 | | .. | | .. | 2 | 54·6 | 0 | 43·6 | .. | Do. |
| 16 | | 23 .. | 3 | 54·1 | 3 | 54·4 | 3 | 55·9 | 4 | 01·8 | 0 | 07·7 | 0·7 = 0·3 | |
| 17 | | 23 .. | 21 | 52·2 | | .. | 21 | 54·6 | 22 | 10·5 | 0 | 18·3 | 0·7 = 0·3 | |
| 18 | | 25 .. | | ? | | .. | 10 | 32·6 | 10 | 39·7 | 0 | 07·1 | .. | Widening of line. Hour signal at 10h. 30m. Sudden displacement of trace through 0·1 mm. at 10h. 32m 6. |
| 19 | May | 6 .. | 19 | 22·3 | 19 | 49·5 | 19 | 57·2 | 21 | 12·0 | 1 | 49·7 | 2·7 = 1·3 | |
| 20 | | 11 .. | 17 | 30·8 ? | 17 | 35·1 | 17 | 35·9 | 18 | 25·7 | 0 | 54·9 | 3·3 = 1·6 | Hour signal at 17h. 30m. |
| 21 | | 15 .. | 0 | 33·3 ? | 0 | 33·3 | 0 | 34·4 | | .. | 0 | 54·1 | 0·4 = 0·2 | Hour signal at 0h. 30m. |
| 22 | | 15 .. | | .. | 1 | 12·0 | 1 | 14·4 | 1 | 27·4 | | | 0·6 = 0·3 | |
| 23 | | 17 .. | 17 | 13·1 | | .. | | .. | 17 | 29·0 | 0 | 15·9 | .. | Widening of line. |
| 24 | | 18 .. | 23 | 09·1 | | .. | | .. | 23 | 25·1 | 0 | 16·0 | .. | Do. |
| 25 | | 19 .. | | .. | 3 | 39·0 | 3 | 39·8 | 3 | 49·1 ? | 0 | 10·1 ? | 0·5 = 0·2 | Instrument examined at 3h. 50m. 8. |
| 26 | | 21 .. | 8 | 33·6 | 8 | 38·2 | 8 | 53·1 | 9 | 29·2 | 0 | 55·6 | 0·9 = 0·4 | |
| 27 | | 21 .. | 10 | 35·1 | | .. | | .. | 10 | 58·1 | 0 | 23·0 | .. | Widening of line. |
| 28 | | 22 .. | 23 | 17·5 | 23 | 23·1 | 23 | 23·6 | 23 | 29·5 | 0 | 12·0 | 0·4 = 0·2 | |
| 29 | | 23 .. | 2 | 29·0 | 2 | 29·5 | 2<br>2<br>2 | 39·9<br>42·0<br>47·9 | 6 | 15·2 | 3 | 46·2 | 13·5 = 5·4<br>14·5 = 5·8<br>16·0 = 6·0 | Burma. |
| 30 | | 28 .. | 7 | 07·1 | | .. | 7 | 08·6 | 7 | 26·7 | 0 | 19·6 | 0·4 = 0·2 | |
| 31 | | 28 .. | 13 | 04·7 | 13 | 26·2 | 13 | 28·2 | 14 | 13·0 | 1 | 08·3 | 0·6 = 0·3 | |
| 32 | June | 1 .. | 0 | 46·3 | | .. | | .. | 0 | 56·6 | 0 | 10·3 | .. | Widening of line. |
| 33 | | 2 .. | 12 | 14·9 | | .. | 12 | 30·2 | 12 | 50·7 | 0 | 35·8 | 0·5 = 0·2 | |
| 34 | | 3 .. | 12 | 31·0 ? | | .. | | .. | 12 | 48·9 | 0 | 17·9 | .. | Widening of line. Hour signal at 12h. 30m. |
| 35 | | 5 .. | 11 | 30·5 ? | 11 | 45·8 | 11 | 48·1 | 12 | 08·8 | 0 | 38·3 | 0·5 = 0·2 | |
| 36 | | 7 .. | 10 | 46·4 | 10 | 50·8 | 10 | 58·2 | | ? | 1 | 11·6 | 0·8 = 0·3 | |
| 37 | | 7 .. | | ? | 11 | 30·0 | 11 | 36·7 | 11 | 58·0 | | | 0·4 = 0·2 | Beginning lost in end of No. 36. |
| 38 | | 7 .. | 13 | 14·6 | | .. | | .. | 13 | 38·2 | 0 | 23·6 | .. | Widening of line. |
| 39 | | 7 .. | 15 | 10·9 | | .. | | .. | 15 | 36·2 | 0 | 25·3 | .. | Do. |
| 40 | | 7 .. | 18 | 55·1 | 19 | 03·3 | 19<br>19 | 09·5<br>26·9 | 20 | 09·4 | 1 | 14·3 | 0·9<br>0·9 = 0·4 | |
| 41 | | 8 .. | 7 | 40·7 | 7 | 47·2 | 7 | 51·0 | 8 | 16·0 ? | 0 | 35·3 ? | 0·8 = 0·3 | |
| 42 | | 8 .. | | ? | 8 | 25·7 | 8 | 37·2 | 9 | 27·0 ? | | .. | 2·4 = 1·0 | |
| 43 | | 8 .. | | ? | 9 | 41·0 | 9 | 48·4 | 10 | 18·0 ? | | .. | 1·4 = 0·6 | |
| 44 | | 8 .. | 13 | 49·9 | 13 | 56·9 | 14 | 02·0 | 14 | 23·1 | 0 | 33·2 | 1·0 = 0·4 | |
| 45 | | 10 .. | 16 | 33·1 | 16 | 58·6 | 17 | 10·1 | 18 | 41·0 ? | 2 | 07·9 | 2·0 = 0·8 | |
| 46 | | 18 .. | 12 | 13·3 | 12 | 43·3 | 12 | 47·4 | 14 | 02·8 | 1 | 49·5 | 1·8 = 0·8 | |
| 47 | | 26 .. | 17 | 07·8 | 17 | 11·4 | 17 | 14·4 | 17 | 55·0 | 0 | 47·2 | 0·9 = 0·4 | June 28th and 29th record incomplete. |
| 48 | July | 7 .. | 8 | 21·4 | 8 | 46·8 | 8 | 58·5 | 11 | 08·0 | 2 | 46·6 | 5·5 = 2·6 | |
| 49 | | 8 .. | 22 | 32·0 | 22 | 47·6 | 22 | 49·2 | 23 | 28·0 | 0 | 56·0 | 0·8 = 0·4 | |

## Kodaikanal Observatory Seismological Records—*cont.*

| No. | Date. | | | P.T. commence G.M.T. | | L.W. commence G.M.T. | | Maxima G.M.T. | | End G.M.T. | | Duration G.M.T. | | Max. Amp. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1912. | | | H. | M. | H. | M. | H. | M. | H. | M. | H. | M. | MM. = " | |
| 50 | July | 24 | .. | 12 | 12·3 | 12 | 13·6 | 12 | 17·4 | | ? | 1 | 52·3 | 1·9 = 0·9 | |
| 51 | | 24 | .. | | ? | 13 | 32·1 | 13 | 37·3 | 14 | 04·6 | | | 0·6 = 0·2 | Beginning lost in end of No. 50. |
| 52 | Aug. | 3 | . | | .. | 9 | 16·0 | 9 | 18·5 | 9 | 28 0 | 0 | 12·0 | 0·6 = 0·2 | No P. Ts. |
| 53 | | 6 | .. | 15 | 28·2 | 13 | 36·3 | 13 | 38·4 | 15 | 26·0 | 1 | 57·8 | 4·8 = 2·0 | |
| 54 | | 6 | .. | 21 | 23·6 | | .. | | .. | 22 | 37·9 | 1 | 14·3 | .. | |
| 55 | | 9 | .. | 1 | 38·7 | 1 | 46·4 | 2 | 06·2 | 5 | 19·0 | 3 | 40·3 | 17 = 7·3 | Widening of line. |
| 56 | | 10 | .. | 22 | 54·0 | | .. | | . | 23 | 17·2 | 0 | 23·8 | .. | Do. |
| 57 | | 17 | .. | 19 | 20·8 | 19 | 28·2 | 19 | 48·1<br>50·4 | 22 | 28·6 | 3 | 07·8 | 5·5 = 2·4<br>5·2 = 2·3 | |
| 58 | | 21 | .. | 17 | 42·8 | | .. | | .. | 18 | 19·7 | 0 | 36·9 | .. | |
| 59 | | 23 | .. | 14 | 08·2 | 14 | 12·3 | 14 | 13 5 | 15 | 10·0 | 1 | 01·8 | 4·5 = 1·9 | Do. |
| 60 | | 23 | .. | 21 | 51·3 | 21 | 53·1 | 21 | 57·4 | 22 | 18·6 | 0 | 22·3 | 1·0 = 0·4 | |
| 61 | Sept. | 1 | .. | 0 | 03·3 | | .. | | .. | 0 | 39·2 | 0 | 35·9 | .. | |
| 62 | | 11 | .. | 0 | 52·3 | 0 | 58·5 | 1 | 00·8 | 1 | 53·6 | 1 | 01·3 | 3·8 = 1·r | Do. |
| 63 | | 13–14 | .. | 23 | 48·5 | 0 | 01·3 | 0 | 09·8 | 0 | 50·5 | 1 | 02·0 | 0·9 = 0·4 | |
| 64 | | 26 | .. | 19 | 32·0 | | .. | | .. | 19 | 56·7 | 0 | 24·7 | .. | |
| 65 | | 29 | .. | 21 | 01·0 | 21 | 09·1 | 21 | 31·5 | | .. | 3 | 16·0 | 2 6 = 1·0 | Do. |
| 66 | | 29–30 | .. | | .. | 23 | 41·5 | 23 | 47·5 | 0 | 17·0 | | | 0·5 = 0·2 | Beginning lost in end of No. 65. |
| 67 | Oct. | 12 | . | 15 | 44·9 | | .. | | . | 17 | 07·4 | 1 | 22·5 | .. | |
| 68 | | 18 | .. | 10 | 18·1 | 10 | 43·0 | 10 | 44·6 | 13 | 22·0 | 3 | 03 9 | 1·0 = 0·4 | Widening of line. |
| 69 | | 31 | .. | 17 | 41·3 | | .. | | . | 18 | 44·4 | 1 | 03·1 | .. | * |
| 70 | Nov. | 7 | .. | 7 | 57·8 | 8 | 33·8 | 8 | 45·3 | 10 | 29·0 | 2 | 31·2 | 2·2 = 1·1 | Widening of line. |
| 71 | Dec. | 1 | .. | 8 | 39·2 | 8 | 51·5 | 8 | 54·5 | 9 | 20·3 | 0 | 41·1 | 0·7 = 0·3 | |
| 72 | | 9 | .. | 0 | 21·3 | 0 | 32·8 | 0 | 34·4 | 1 | 03·7 | 0 | 42·4 | 0·5 = 0·2 | |
| 73 | | 9 | .. | 9 | 54·1 | 10 | 28·0 | 10 | 30·3 | 10 | 48·5 | 0 | 54 4 | 0·6 = 0·3 | |
| 74 | | 10 | .. | 2 | 49·0 | | .. | | .. | 3 | 35·1 | 0 | 46·1 | .. | |
| 75 | | 20 | .. | 20 | 12·6 | | .. | | .. | 20 | 44·4 | 0 | 31·8 | .. | Do. |
| 76 | | 23 | .. | 17 | 43·8 | | .. | | .. | 18 | 32·3 | 0 | 48·5 | .. | Do. |
| 77 | | 24 | .. | 0 | 02·8 | 0 | 25·4 | 0 | 32·0 | 0 | 54·1 | 0 | 51·3 | 0·7 = 0·3 | Do. |
| 78 | | 24 | .. | 18 | 30·0 ? | 18 | 36·2 | 18 | 38·0 | 18 | 52·6 | 0 | 23·0 ? | 0·5 = 0·2 | Hour signal at $18^h. 30^m$. |
| 79 | | 25 | .. | 17 | 33·8 | | . | 17 | 38·8 | 18 | 16·9 | 0 | 43·1 | 0·4 = 0·2 | |
| 80 | | 27 | .. | 0 | 09 0 | | .. | | .. | 1 | 46·4 | 1 | 37·4 | .. | |
| 81 | | 28 | .. | 8 | 09·0 | 8 | 27·7 | 8 | 32·0 | 9 | 08·0 | 0 | 59 0 | 0·7 = 0·3 | Widening of line. |

* Instrument disturbed in the day-time from the 17th to 23rd October during building operations.

# Appendix II.

LATITUDE, 10° 13′ 50″ N.
LONGITUDE, 5h 9m 52s E.

Height of barometer cistern above mean sea level, 7,688 feet.

MEAN monthly and annual meteorological results at the Kodaikanal Observatory in 1912.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer. Mean. | Dry bulb thermometer. Max. | Dry bulb thermometer. Min. | Dry bulb thermometer. Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. By Blanford's tables. | Relative humidity. By Blanford's tables. | Sun Max. *in vac.* | Min. on grass. | Wind. Daily velocity. | Wind. Mean direction. | Wind. Mean direction. | Rain. Amount. | Rain. Days. | Clear sky. | Bright sunshine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | POINTS. | POINTS. | INCHES. | NO. | CENTS. | HOURS. |
| January .. .. | 22·867 | 0·062 | 54·2 | 65·6 | 46·2 | 19·4 | 44·2 | 36·6 | 0·195 | 49 | 125·3 | 34·0 | 306 | 4 | N.E. | 0·70 | 2 | 80 | 278 6 |
| February .. | ·858 | ·068 | 56·5 | 67·6 | 49·4 | 18·2 | 50·3 | 43·4 | ·305 | 67 | 134 7 | 40·2 | 242 | 7 | E. by N. | 0·64 | 2 | 65 | 233·1 |
| March .. .. | ·867 | ·064 | 59·0 | 69·7 | 52·2 | 17·5 | 51·4 | 44·9 | ·307 | 62 | 136·6 | 44·7 | 271 | 9 | E. by S. | 1·14 | 3 | 62 | 222·2 |
| April .. | ·867 | ·064 | 60·6 | 71·0 | 53·4 | 17·6 | 54·3 | 48·0 | ·363 | 68 | 140·7 | 48·1 | 282 | 8 | E. | 10·05 | 8 | 59 | 232·0 |
| May .. .. | ·828 | ·066 | 61·5 | 70·8 | 55·3 | 15·5 | 56·5 | 51·1 | ·408 | 75 | 140·6 | 50·1 | 233 | 4 | N.E. | 5·95 | 9 | 42 | 203·3 |
| June .. .. | ·766 | ·057 | 58·6 | 65·4 | 54·1 | 11·3 | 54·9 | 50·9 | ·396 | 80 | 131·4 | 51·1 | 390 | 26 | W.N.W. | 3·76 | 7 | 21 | 89·9 |
| July .. .. | ·746 | ·054 | 56·6 | 62·5 | 53·1 | 9·4 | 53·3 | 49·5 | ·377 | 82 | 129·2 | 50·1 | 408 | 26 | W.N.W. | 3·29 | 7 | 19 | 77·9 |
| August .. .. | ·768 | ·058 | 56·8 | 63·5 | 52·5 | 11·0 | 53·9 | 49·5 | 388 | 84 | 121·4 | 49·5 | 358 | 26 | W.N.W. | 5·39 | 9 | 24 | 124·4 |
| September .. | ·792 | ·066 | 57·8 | 66·2 | 52·2 | 14·0 | 54·3 | 49·2 | ·388 | 81 | 133·3 | 49·4 | 202 | 30 | N.N.W. | 7·04 | 11 | 32 | 119·9 |
| October .. | ·813 | ·067 | 55·7 | 62·0 | 51·6 | 10·4 | 53·8 | 49·3 | ·398 | 89 | 120·5 | 48·2 | 280 | 31 | N. by W. | 10·73 | 22 | 14 | 85·7 |
| November .. | ·820 | ·062 | 53·9 | 61·0 | 49·1 | 11·9 | 52·0 | 47·0 | ·372 | 89 | 117·2 | 44·5 | 280 | 2 | N.N.E. | 11·29 | 13 | 32 | 113·1 |
| December .. | ·851 | ·062 | 54·7 | 64·2 | 47·8 | 16·4 | 47·8 | 41·1 | ·269 | 63 | 120·8 | 40·0 | 381 | 7 | E. by N. | 5·25 | 9 | 54 | 217·3 |
| Annual .. | 22·820 | 0·062 | 57·2 | 65·8 | 51·4 | 14·4 | 52·2 | 46·7 | 0·347 | 74 | 129·3 | 45·8 | 303 | 2 | N.N.E. | 65·23 | 102 | 42 | 1,997·4 |

EXTREME monthly meteorological records at the Kodaikanal Observatory in 1912.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry bulb thermometer. Highest. | | Dry bulb thermometer. Lowest. | | Wet bulb. Lowest. | | Humidity. Lowest. | | Sun Th. *in vacuo.* Highest. | | Grass therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES | DAY. | INCHES. | DAY. |
| January .. | 22·981 | 19 | 22·781 | 8,10,11 | 0·197 | 72·7 | 10 | 40 7 | 7 | 31·3 | 4 | 11 | 5,10 | 135·9 | 30 | 24·1 | 10 | 525 | 19 | 144 | 30 | 0·36 | 17 |
| February .. | ·948 | 1 | ·771 | 25 | ·177 | 71·5 | 10 | 44·2 | 22 | 37·6 | 11 | 18 | 11 | 144·9 | 14 | 34·6 | 11,21 | 371 | 8 | 131 | 28 | 0·42 | 29 |
| March .. .. | 939 | 20 | ·800 | 14 | ·139 | 75·8 | 28 | 45·3 | 11 | 37·3 | 17 | 10 | 17 | 150·8 | 13 | 38·0 | 15 | 446 | 23 | 118 | 3 | 0 46 | 4 |
| April .. .. | ·976 | 12 | 787 | 20 | ·189 | 75·8 | 9 | 50·6 | 2 | 40·9 | 3 | 26 | 10 | 146·9 | 6 | 41·7 | 14 | 407 | 2 | 183 | 29 | 4·07 | 17 |
| May .. .. | ·901 | 4,7 | ·759 | 13 | ·142 | 77·3 | 19 | 52·8 | 28 | 46·5 | 26 | 43 | 19 | 148·8 | 15 | 45·1 | 23 | 355 | 11 | 109 | 22 | 1·27 | 9 |
| June .. .. | ·861 | 3 | ·683 | 9 | ·178 | 73·5 | 2 | 51·2 | 5 | 47·7 | 30 | 47 | 2 | 145·9 | 20 | 45·4 | 2 | 608 | 29 | 147 | 7 | 1·02 | 2 |
| July .. .. | ·835 | 3 | ·653 | 28 | ·182 | 67·8 | 3 | 50·2 | 23 | 45·1 | 22 | 46 | 22 | 144·9 | 6 | 43·9 | 3 | 693 | 22 | 200 | 1 | 0·71 | 11 |
| August .. .. | ·854 | 13 | ·676 | 24 | ·178 | 69·2 | 8 | 49·5 | 1 | 45·2 | 14 | 54 | 14 | 144·7 | 1 | 45·2 | 31 | 685 | 25 | 110 | 13 | 1·38 | 20 |
| September .. | ·868 | 9 | ·691 | 5 | ·177 | 70·6 | 11 | 50·0 | 3 | 41·3 | 23 | 38 | 23 | 150·9 | 11 | 37 6 | 7 | 329 | 22 | 120 | 25 | 1·42 | 13 |
| October .. .. | ·906 | 9 | ·716 | 30 | ·190 | 66·2 | 17 | 46·4 | 31 | 35·2 | 31 | 25 | 30 | 143·2 | 26 | 38 6 | 30 | 478 | 16 | 142 | 4 | 1·85 | 15 |
| November .. | ·894 | 23 | ·712 | 19 | ·182 | 70·3 | 13 | 43·9 | 7 | 36·6 | 13 | 36 | 13 | 139 9 | 14 | 30·0 | 7 | 624 | 19 | 140 | 7 | 2·72 | 20 |
| December .. | ·930 | 4 | ·757 | 18 | ·173 | 70·8 | 24 | 40·9 | 11 | 32·6 | 7 | 13 | 26 | 133·1 | 7 | 29·8 | 24 | 766 | 18 | 222 | 5 | 2·41 | 19 |

# Appendix III.

KODAIKANAL mean hourly wind velocity for the year 1912.

| Month. | Hours. | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| January . | 15 | 14 | 14 | 14 | 23 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 12 | 14 | 10 | 8 | 8 | 10 | 12 | 14 | 14 | 15 | 15 |
| Februry .. .. | 10 | 10 | 11 | 10 | 10 | 10 | 11 | 11 | 14 | 14 | 15 | 14 | 12 | 12 | 11 | 10 | 8 | 7 | 7 | 7 | 8 | 9 | 9 | 10 |
| March .. .. | 11 | 11 | 11 | 12 | 13 | 12 | 12 | 13 | 14 | 14 | 14 | 14 | 11 | 11 | 10 | 9 | 8 | 9 | 9 | 10 | 10 | 10 | 11 | 13 |
| April .. | 11 | 11 | 12 | 12 | 12 | 13 | 13 | 13 | 15 | 14 | 15 | 14 | 14 | 13 | 12 | 11 | 10 | 9 | 10 | 11 | 10 | 11 | 10 | 10 |
| May .. | 11 | 11 | 9 | 9 | 10 | 10 | 9 | 9 | 10 | 11 | 11 | 10 | 11 | 10 | 10 | 10 | 9 | 8 | 9 | 9 | 8 | 10 | 9 | 10 |
| June .. | 18 | 18 | 18 | 19 | 18 | 17 | 17 | 16 | 14 | 15 | 16 | 16 | 14 | 14 | 14 | 15 | 15 | 16 | 16 | 16 | 16 | 16 | 17 | 19 |
| July .. | 18 | 19 | 19 | 19 | 19 | 17 | 17 | 17 | 16 | 15 | 16 | 17 | 15 | 15 | 15 | 15 | 15 | 16 | 17 | 17 | 18 | 17 | 19 | 19 |
| August .. | 17 | 16 | 16 | 15 | 16 | 15 | 16 | 14 | 15 | 14 | 14 | 14 | 12 | 12 | 12 | 13 | 13 | 15 | 15 | 16 | 17 | 17 | 18 | 17 |
| September .. | 9 | 9 | 9 | 9 | 10 | 8 | 8 | 8 | 8 | 9 | 8 | 9 | 9 | 9 | 8 | 9 | 8 | 7 | 8 | 7 | 8 | 8 | 8 | 9 |
| October .. | 13 | 13 | 12 | 12 | 13 | 12 | 11 | 11 | 12 | 12 | 11 | 11 | 10 | 11 | 10 | 10 | 11 | 10 | 11 | 12 | 12 | 13 | 13 | 13 |
| November .. | 13 | 13 | 13 | 14 | 13 | 12 | 12 | 13 | 12 | 13 | 12 | 12 | 11 | 11 | 10 | 10 | 10 | 9 | 10 | 9 | 10 | 12 | 12 | 12 |
| December .. | 16 | 16 | 16 | 17 | 17 | 16 | 17 | 16 | 17 | 18 | 18 | 18 | 17 | 15 | 15 | 11 | 13 | 13 | 14 | 15 | 15 | 16 | 16 | 17 |
| Mean .. | 14 | 13 | 13 | 14 | 14 | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 12 | 12 | 12 | 11 | 11 | 11 | 11 | 12 | 12 | 13 | 13 | 14 |

## Appendix IV.

Kodaikanal mean hourly bright sunshine for the year 1912.

| Month. | | Hours. | | | | | | | | | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6–7 | 7–8 | 8–9 | 9–10 | 10–11 | 11–12 | 12–13 | 13–14 | 14–15 | 15–16 | 16–17 | 17–18 | |
| January .. .. | 0·04 | 0·91 | 0·95 | 0·94 | 0·91 | 0·88 | 0·87 | 0·86 | 0·82 | 0·79 | 0·76 | 0·27 | |
| February .. .. | ·19 | ·86 | ·92 | ·97 | ·92 | ·84 | ·73 | ·69 | ·60 | ·57 | ·52 | ·23 | |
| March .. .. | ·02 | ·82 | ·88 | ·84 | ·79 | ·79 | ·69 | ·63 | ·48 | ·43 | ·44 | ·35 | |
| April .. .. .. | ·04 | ·86 | ·94 | ·97 | ·90 | ·83 | ·76 | ·69 | ·65 | ·50 | ·33 | ·24 | |
| May .. .. .. | ·25 | ·75 | ·87 | ·81 | ·82 | ·78 | ·70 | ·53 | ·43 | ·35 | ·21 | ·05 | |
| June .. .. .. | ·08 | ·40 | ·38 | ·37 | ·38 | ·36 | ·35 | ·22 | ·23 | ·14 | ·07 | .. | |
| July .. .. .. | ·05 | ·20 | ·33 | ·39 | ·34 | ·29 | ·21 | ·17 | ·17 | ·21 | ·12 | ·05 | |
| August .. .. | ·12 | ·42 | ·50 | ·61 | ·53 | ·41 | ·39 | ·30 | ·34 | ·22 | ·14 | ·03 | |
| September .. .. | ·17 | ·55 | ·67 | ·65 | ·50 | ·44 | ·29 | ·29 | ·14 | ·16 | ·09 | ·04 | |
| October .. .. | ·04 | ·22 | ·40 | ·43 | ·35 | ·27 | ·24 | ·26 | ·25 | ·19 | ·08 | ·03 | |
| November .. .. | ·01 | ·40 | ·46 | ·56 | ·51 | ·43 | ·43 | ·39 | ·30 | ·18 | ·11 | .. | |
| December .. .. | ·06 | ·64 | ·73 | ·73 | ·71 | ·71 | ·71 | ·70 | ·65 | ·69 | ·58 | ·11 | |
| Mean .. | 0·09 | 0·59 | 0·65 | 0·69 | 0·64 | 0·55 | 0·53 | 0·48 | 0·42 | 0·37 | 0·29 | 0·12 | |

## Appendix V.

Number of days in each month on which the Nilgiris were visible in 1912.

| Month. | Very clear. | Visible. | Just visible. | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January .. .. .. .. | .. | 20 | 4 | 2 | 26 |
| February .. .. .. .. | .. | 3 | 7 | 3 | 13 |
| March .. .. .. .. | .. | 4 | 1 | .. | 5 |
| April .. .. .. .. | .. | .. | .. | 1 | 1 |
| May .. .. .. .. .. | .. | 1 | 2 | .. | 3 |
| June .. .. .. .. .. | 4 | 6 | 3 | .. | 13 |
| July .. .. .. .. .. | 1 | 4 | 4 | 1 | 10 |
| August .. .. .. .. | 1 | 3 | 2 | .. | 6 |
| September .. .. .. .. | 6 | 7 | 2 | .. | 15 |
| October .. .. .. .. | .. | 13 | 1 | .. | 14 |
| November .. .. .. .. | 2 | 3 | 2 | .. | 7 |
| December .. .. .. .. | 1 | 20 | 1 | 2 | 24 |
| Total .. | 15 | 84 | 29 | 9 | 137 |

# Appendix VI.

Madras Observatory.—Abnormals from monthly means for the year 1912.

| Abnormals of | January. | February. | March. | April. | May. | June. | July. | August | September. | October. | November. | December. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure .. .. .. | + 0·037 | − 0·014 | − 0·007 | + 0·051 | + 0·011 | − 0·02 | − 0·030 | − 0·031 | − 0·005 | + 0·004 | − 0·013 | + 0·029 | Same as |
| Temperature of air .. .. .. .. .. | − 0·9 | + 2·2 | + 2·5 | + 0·7 | + 2·3 | + 2·8 | + 1·4 | + 1·2 | + 1·7 | + 1·5 | + 0·5 | − 0·3 | + 1·3 |
| Do. of evaporation .. .. .. | + 0·5 | + 3·0 | + 2·8 | + 1·5 | + 3·4 | + 3·6 | + 2·6 | + 2·5 | + 2·9 | + 1·9 | + 1·6 | − 0·5 | + 2·1 |
| Percentage of humidity .. .. .. .. | + 5 | + 5 | + 2 | + 3 | + 5 | + 4 | + 6 | + 5 | + 5 | + 3 | + 6 | − 1 | + 4 |
| Greatest solar heat *in vacuo* .. .. .. .. | − 9·4 | − 6·7 | − 4·1 | − 5·4 | − 2·4 | − 0·5 | − 8·4 | − 6·2 | − 2·4 | − 5·3 | − 8·6 | − 5·7 | − 5·4 |
| Maximum in shade . .. .. .. .. | − 1·1 | + 0·1 | + 2·5 | Same as | + 2·4 | + 2·9 | + 1·2 | + 2·2 | + 1·3 | + 1·2 | + 0·3 | − 0·2 | + 1·1 |
| Minimum in shade .. .. .. .. .. | − 1·8 | − 3·3 | + 2·2 | + 0·2 | + 1·7 | + 2·9 | + 1·2 | + 0·4 | + 1·3 | + 0·6 | Same as | − 1·4 | + 0·9 |
| Do. on grass .. .. .. .. .. | − 1·3 | − 4·4 | + 3·0 | + 0·3 | + 2·2 | + 4·2 | + 1·7 | + 0·8 | + 2·1 | + 1·6 | + 1·4 | − 1·0 | + 1·6 |
| Rainfall in inches .. .. .. .. .. | + 1·94 | − 0·28 | − 0·39 | − 0·62 | − 2·12 | − 0·33 | − 1·65 | + 0·83 | − 3·33 | Same as | + 8·60 | − 4·98 | .. |
| Do. since January .. .. .. .. .. | .. | + 1·66 | + 1·27 | + 0·65 | − 1·47 | − 1·80 | − 3·45 | − 2·62 | − 5·95 | − 5·95 | + 2·65 | − 2·33 | − 2·33 |
| General direction of wind .. .. .. . | 1 point N. | 2 points S. | 1 point S. | Same as | 1 point E | 1 point S. | Same as | 1 point W. | 2 points S. | 2 points N. | 2 points E. | Same as | Same as |
| Daily velocity in miles .. .. .. .. | − 39 | − 7 | + 8 | − 23 | − 19 | − 7 | − 43 | − 21 | − 28 | − 10 | − 23 | − 21 | − 19 |
| Percentage of cloudy sky .. .. .. .. | − 18 | Same as | − 11 | − 8 | − 12 | − 23 | + 4 | + 2 | − 15 | − 6 | − 10 | − 18 | − 15 |
| Do. of bright sunshine .. .. .. .. | − 1·4 | − 2·1 | + 4·0 | + 8·2 | − 3·4 | + 3·2 | − 11·3 | − 5·0 | + 2·4 | − 5·1 | − 2·4 | + 4·1 | − 5·2 |

+ Means above normal, — below normal.

## Appendix VII.

**Abstract** of the mean meteorological condition of Madras in the year 1912 compared with the average of past years.

| Mean values of | 1912. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure | 29·864 | same as | 29·864 |
| Temperature of air | 82·4 | 1·3 above. | 81·1 |
| Do. of evaporation | 76·6 | 2·1 ,, | 74·5 |
| Percentage of humidity | 76 | 4 ,, | 72 |
| Greatest solar heat *in vacuo* | 134·3 | 5·4 below. | 139·7 |
| Maximum in shade | 91·9 | 1·1 above. | 90·8 |
| Minimum in shade | 75·6 | 0·9 ,, | 74·7 |
| Do. on grass | 73·5 | 1·6 ,, | 71·9 |
| Rainfall since January 1st on 78 days | 46·69 | 2·33 below. | 49·02 |
| General direction of wind | S.E. | Same as | S.E. |
| Daily velocity in miles | 152 | 19 below. | 171 |
| Percentage of cloudy sky | 34 | 15 ,, | 49 |
| Do. of bright sunshine | 53·2 | 5·2 ,, | 58·4 |

**Duration** and quantity of the wind from different points.

| From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 204 | 1,463 | East | 223 | 1,232 | South | 200 | 1,374 | West | 283 | 2,033 |
| N. by E. | 416 | 2,260 | E. by S. | 304 | 1,702 | S. by W. | 264 | 1,550 | W. by N. | 200 | 1,576 |
| N.N.E. | 474 | 2,728 | E.S.E. | 423 | 2,315 | S.S.W. | 248 | 1,664 | W.N.W. | 116 | 862 |
| N.E. by N. | 467 | 3,006 | S.E. by E. | 659 | 3,807 | S.W. by S. | 202 | 1,330 | N.W. by W. | 102 | 604 |
| N.E. | 176 | 1,078 | S.E. | 457 | 3,302 | S.W. | 191 | 1,161 | N.W. | 36 | 247 |
| N.E. by E. | 165 | 855 | S.E. by S. | 829 | 6,894 | S.W. by W. | 201 | 1,238 | N.W. by N. | 43 | 200 |
| E.N.E. | 204 | 927 | S.S.E. | 445 | 3,308 | W.S.W. | 206 | 1,549 | N.N.W. | 80 | 517 |
| E. by N. | 156 | 773 | S. by E. | 231 | 1,668 | W. by S. | 244 | 1,726 | N. by W. | 101 | 663 |

There were 234 calm hours during the year. The resultant corresponding to the above numbers is represented by a south-east wind, blowing with a uniform daily velocity of 42 miles.

# Appendix VIII.

Madras Observatory—Number of hours of wind from each point in the year 1912.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. | 25 | 72 | 59 | 135 | 80 | 106 | 76 | 52 | 62 | 29 | 11 | .. | . | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 13 | 24 |
| February .. | .. | .. | .. | .. | .. | | 36 | 12 | 52 | 163 | 183 | 116 | 57 | 17 | 3 | 3 | 5 | 3 | 2 | .. | 2 | 2 | 4 | 2 | 1 | .. | . | .. | .. | .. | .. | .. | 33 |
| March .. | .. | 1 | .. | 13 | 1 | .. | 2 | 18 | 4 | 3 | 52 | 107 | 82 | 224 | 36 | 14 | 33 | 27 | 31 | 17 | 10 | 3 | .. | .. | .. | .. | .. | . | .. | | .. | .. | 16 |
| April .. | .. | .. | . | .. | .. | .. | .. | | .. | 3 | 47 | 141 | 140 | 221 | 76 | 10 | 7 | 11 | 18 | 8 | 5 | 2 | 4 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 27 |
| May .. .. | .. | .. | 1 | .. | 1 | 9 | 16 | 10 | 17 | 15 | 34 | 67 | 49 | 133 | 91 | 56 | 29 | 41 | 37 | 29 | 14 | 16 | 21 | 8 | 11 | 10 | 6 | .. | 1 | .. | 3 | .. | 19 |
| June .. .. | .. | .. | .. | .. | 2 | .. | .. | 1 | 5 | 10 | 6 | 11 | 28 | 60 | 87 | 60 | 33 | 30 | 46 | 20 | 29 | 46 | 70 | 60 | 19 | 29 | 5 | 2 | 6 | .. | 3 | .. | 2 |
| July .. .. | .. | .. | 3 | .. | 1 | 3 | 2 | 3 | 6 | 11 | 13 | 36 | 17 | 22 | 16 | 20 | 16 | 40 | 41 | 59 | 43 | 63 | 29 | 68 | 78 | 72 | 33 | 18 | 6 | 10 | 1 | .. | 14 |
| August .. | 7 | 2 | .. | .. | 1 | .. | 2 | 3 | 7 | 2 | 10 | 27 | 30 | 26 | 32 | 15 | 36 | 62 | 39 | 27 | 37 | 33 | 55 | 57 | 72 | 65 | 34 | 28 | 15 | 3 | 3 | 1 | 13 |
| September .. | 11 | 12 | 2 | 2 | 3 | .. | 4 | 14 | 5 | 8 | 23 | 93 | 44 | 118 | 24 | 29 | 23 | 29 | 25 | 30 | 15 | 28 | 7 | 40 | 16 | 11 | 16 | 29 | 6 | 10 | 6 | 6 | 21 |
| October .. | 17 | 14 | 61 | 34 | 40 | 19 | 34 | 30 | 38 | 48 | 31 | 40 | 7 | 7 | .. | 6 | 16 | 16 | 9 | 7 | 29 | 7 | 3 | 8 | 22 | 10 | 21 | 19 | 2 | 16 | 50 | 35 | 48 |
| November .. | 111 | 126 | 57 | 94 | 33 | 25 | 13 | 13 | 27 | 12 | 13 | 21 | 3 | 1 | 30 | 18 | 2 | 5 | .. | 5 | 7 | 1 | 3 | 1 | 14 | 3 | 1 | 6 | . | 4 | 14 | 43 | 14 |
| December . | 33 | 189 | 291 | 189 | 14 | 3 | 19 | .. | .. | .. | .. | . | .. | .. | .. | .. | .. | . | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 | 3 |
| Annual total .. | 204 | 416 | 474 | 467 | 176 | 165 | 204 | 156 | 223 | 304 | 423 | 659 | 457 | 829 | 445 | 231 | 200 | 264 | 248 | 202 | 191 | 201 | 206 | 244 | 283 | 200 | 116 | 102 | 36 | 43 | 80 | 101 | 234 |

# Appendix IX.

MADRAS OBSERVATORY.—Number of miles of wind from each point in the year 1912.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. .. .. .. | 134 | 298 | 257 | 500 | 401 | 488 | 343 | 226 | 292 | 199 | 60 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 60 | 3258 |
| February .. .. .. .. .. | .. | .. | .. | .. | .. | .. | 71 | 68 | 296 | 810 | 849 | 679 | 302 | 143 | 21 | 12 | 25 | 16 | 9 | .. | 5 | 5 | 17 | 10 | 3 | .. | .. | .. | .. | .. | .. | .. | 3341 |
| March .. .. .. .. .. | .. | 8 | .. | 52 | 10 | .. | 12 | 75 | 35 | 25 | 247 | 577 | 454 | 1772 | 606 | 87 | 266 | 221 | 290 | 141 | 58 | 9 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 4945 |
| April .. .. .. .. .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 35 | 316 | 781 | 1233 | 1677 | 513 | 60 | 59 | 75 | 148 | 67 | 30 | 12 | 38 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 5044 |
| May .. .. .. .. .. | .. | .. | 8 | .. | 2 | 32 | 79 | 107 | 110 | 158 | 226 | 555 | 419 | 1345 | 781 | 569 | 334 | 346 | 315 | 260 | 142 | 124 | 180 | 75 | 102 | 97 | 60 | .. | 6 | .. | 15 | .. | 6447 |
| June .. .. .. .. .. | .. | .. | .. | .. | 18 | .. | .. | 5 | 51 | 88 | 48 | 115 | 299 | 708 | 836 | 482 | 246 | 181 | 283 | 160 | 226 | 356 | 684 | 521 | 672 | 292 | 43 | 16 | 49 | .. | 21 | .. | 6400 |
| July .. .. .. .. .. | .. | .. | 23 | .. | 9 | 16 | 29 | 12 | 40 | 64 | 69 | 242 | 153 | 185 | 125 | 112 | 95 | 193 | 207 | 284 | 261 | 406 | 194 | 500 | 572 | 522 | 291 | 120 | 47 | 34 | 10 | .. | 4815 |
| August .. .. .. .. | 16 | 2 | .. | .. | 9 | .. | 10 | 22 | 50 | 18 | 79 | 182 | 165 | 222 | 196 | 121 | 178 | 293 | 255 | 205 | 254 | 190 | 313 | 378 | 458 | 518 | 269 | 193 | 100 | 27 | 16 | 5 | 4744 |
| September .. .. .. .. | 38 | 34 | 18 | 20 | 16 | .. | 27 | 41 | 35 | 62 | 157 | 441 | 213 | 790 | 144 | 154 | 112 | 162 | 128 | 157 | 88 | 104 | 95 | 192 | 92 | 90 | 121 | 183 | 37 | 46 | 23 | 22 | 3842 |
| October .. .. .. .. | 105 | 91 | 311 | 237 | 235 | 163 | 212 | 135 | 212 | 180 | 167 | 158 | 51 | 44 | .. | 25 | 48 | 41 | 29 | 30 | 76 | 28 | 15 | 45 | 77 | 42 | 70 | 70 | 8 | 68 | 331 | 199 | 3503 |
| November .. .. .. .. | 831 | 568 | 378 | 729 | 283 | 135 | 75 | 82 | 111 | 64 | 97 | 77 | 13 | 8 | 85 | 46 | 11 | 22 | .. | 26 | 21 | 4 | 13 | 5 | 57 | 15 | 8 | 22 | .. | 25 | 101 | 350 | 4263 |
| December .. .. .. .. | 339 | 1259 | 1733 | 1468 | 95 | 21 | 69 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 27 | 5011 |
| Annual .. | 1463 | 2260 | 2728 | 3006 | 1078 | 855 | 927 | 773 | 1232 | 1703 | 2315 | 3807 | 3302 | 6894 | 3308 | 1668 | 1374 | 1550 | 1664 | 1330 | 1161 | 1238 | 1549 | 1726 | 2033 | 1576 | 862 | 604 | 247 | 200 | 517 | 663 | 55613 |

# Appendix X.

MADRAS OBSERVATORY.—Number of inches of rain from each point in the year 1912.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. | 0·25 | 1·18 | .. | .. | .. | .. | .. | 0·14 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1·24 | 0·02 |
| February .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| March .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| April .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| May .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| June .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·03 | 0·02 | .. | .. | .. | .. | 0·20 | .. | .. | 0·12 | .. | .. | .. | 1·41 | .. | .. | .. | .. |
| July .. | .. | .. | .. | .. | .. | .. | 0·08 | 0·04 | 0·07 | .. | .. | 0·18 | .. | 0·02 | 0·06 | .. | 0·18 | 0·10 | 0·10 | 0·16 | 0·21 | 0·04 | 0·02 | 0·03 | 0·05 | 0·41 | 0·42 | 0·04 | 0·01 | .. | .. | .. | .. |
| August .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·02 | .. | 0·09 | .. | 0·02 | 0·01 | .. | 0·06 | 0·05 | 0·09 | 0·02 | 0·13 | 0·10 | 0·77 | .. | 0·31 | .. | 0·20 | 0·80 | 1·04 | 0·11 | 0·97 | 0·60 | .. | .. |
| September .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 0·10 | .. | 0·10 | .. | .. | .. | 0·07 | .. | .. | .. | 0·22 | .. | 0·05 | .. | 0·81 | 0·01 | .. | .. | .. | .. | .. |
| October .. | 0·31 | .. | 0·37 | 0·21 | 0·41 | .. | 0·06 | 0·25 | 0·86 | 0·01 | 0·19 | .. | .. | 0·81 | .. | .. | 0·49 | 0·26 | 0·01 | 0·50 | 0·88 | .. | .. | 1·03 | .. | .. | 0·16 | .. | .. | 0·24 | 3·31 | 0·46 | 0·18 |
| November .. | 1·66 | 0·84 | 0·48 | 2·44 | 1·67 | 0·76 | 1·06 | 2·69 | 1·30 | 0·08 | 1·96 | 1·46 | 0·21 | .. | 0·55 | .. | .. | 0·14 | .. | 3·58 | 0·05 | .. | .. | .. | .. | .. | .. | .. | 0·58 | .. | 0·06 | 0·25 | .. |
| December .. | .. | 0·02 | 0·02 | 0·26 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Annual .. | 2·22 | 2·04 | 0·87 | 2·91 | 2·08 | 0·76 | 1·20 | 3·12 | 2·25 | 0·09 | 2·24 | 1·64 | 0·33 | 0·84 | 0·71 | 0·09 | 0·74 | 0·59 | 0·20 | 4·37 | 1·24 | 1·01 | 0·24 | 1·37 | 0·22 | 0·61 | 2·19 | 1·09 | 2·11 | 1·21 | 3·96 | 1·95 | 0·20 |

# Appendix XI.

MADRAS OBSERVATORY.—Wind, cloud and bright sunshine, 1912.

| Month. | Wind resultant. | | Clouds (0—10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H. | 16 H. | 20 H. | Mean. | Average per day. | Greatest number of hours in a day. |
| | MILES. | POINTS. | | | | | | HOURS. | HOURS. |
| January .. .. | 92 | N.E. | 1·9 | 2·7 | 2·2 | 0·8 | 1·9 | 7·6 | 9·1 |
| February .. .. | 107 | E. S. E. | 2·6 | 3·7 | 1·9 | 1·1 | 2·4 | 8·8 | 10·6 |
| March .. .. | 138 | S. E. by S. | 1·7 | 1·8 | 1·0 | 0·7 | 1·3 | 9·3 | 10·5 |
| April .. .. | 156 | S. E. by S. | 2·9 | 3·3 | 1·1 | 0·6 | 2·0 | 9·6 | 11·0 |
| May .. .. | 151 | S.S.E. | 3·5 | 3·1 | 2·0 | 1·4 | 2·6 | 7·2 | 9·2 |
| June .. .. | 132 | S.S.W. | 3·6 | 3·1 | 4·9 | 4·7 | 4 1 | 5·5 | 7·9 |
| July .. .. | 87 | S. W. by W. | 7·3 | 7·2 | 7·6 | 7·7 | 7·5 | 2·5 | 8·2 |
| August .. .. | 82 | S.W. by W. | 7·1 | 6·8 | 6 5 | 6·8 | 6·9 | 4·3 | 10·0 |
| September .. .. | 62 | S. by E. | 4·3 | 4·4 | 5·6 | 4·4 | 4·7 | 5·3 | 9·3 |
| October .. .. | 50 | N.E. | 5·0 | 5·8 | 5·6 | 4·6 | 5·3 | 5·3 | 9·8 |
| November . .. | 93 | N.N.E. | 4·7 | 5·4 | 5·5 | 4·0 | 4 9 | 5·3 | 9·7 |
| December .. .. | 158 | N.N.E. | 2·9 | 3·8 | 4·1 | 2·7 | 3·4 | 6·5 | 8·3 |
| Annual .. | 42 | S E. | 4·0 | 4·3 | 4·0 | 3·3 | 3·9 | 6·4 | — |

# Appendix XII.

## Mean Monthly and Annual Meteorological Results at the Madras Observatory in 1912.

| Months. | Barometer. | | Dry bulb thermometer. | | | | Wet bulb. | | Tension of vapour. | Relative humidity. | Sun Max. *in vac.* | Min. on grass. | Wind. | | | Rain. | | Cloudy sky. | Bright sun-shine. | General weather. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reduced to 32°. | Daily range. | Mean. | Max. | Min. | Range. | Mean. | Min. | By Blanford's tables. | | | | Daily velo-city. | Mean direction. | | Amount. | Days. | | | |
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | PTS. | POINTS. | INCHES. | NO. | CENTS. | HOURS. | |
| January .. | 30·034 | 0·108 | 74·2 | 83·5 | 65·7 | 17·8 | 69·7 | 65·4 | 0·654 | 73 | 129·0 | 61·8 | 105 | 4 | N.E. | 2·83 | 2 | 19 | 235·6 | |
| February .. | 29·950 | ·116 | 78·9 | 86·7 | 71·3 | 15·4 | 73·8 | 70·8 | ·768 | 78 | 133·0 | 68·2 | 115 | 10 | E.S.E. | .. | .. | 24 | 254·0 | |
| March .. | ·898 | ·133 | 82·5 | 91·7 | 74·3 | 17·4 | 76·7 | 73·5 | ·839 | 76 | 136·4 | 71·6 | 160 | 13 | S.E. by S. | .. | .. | 13 | 289·6 | |
| April .. | ·875 | ·126 | 84·7 | 92·9 | 77·4 | 15·5 | 79·1 | 76·5 | ·916 | 77 | 136·3 | 75·0 | 168 | 13 | S.E. by S. | .. | .. | 6 | 289·2 | |
| May .. | ·746 | ·122 | 89·0 | 100·2 | 82·5 | 17·7 | 81·7 | 78·6 | ·981 | 72 | 140·6 | 81·1 | 208 | 14 | S.S.E. | .. | .. | 26 | 224·6 | |
| June .. | ·680 | ·117 | 89·2 | 101·2 | 83·2 | 18·0 | 80·2 | 76·6 | ·900 | 66 | 140·0 | 82·8 | 213 | 18 | S.S.W. | 1·78 | 4 | 41 | 165·2 | |
| July .. | ·686 | ·120 | 85·9 | 96·8 | 79·7 | 17·1 | 78·5 | 77·8 | ·875 | 71 | 130·3 | 78·3 | 155 | 20 | S.W. | 2·22 | 17 | 75 | 79·0 | |
| August .. | ·718 | ·129 | 84·5 | 95·9 | 77·7 | 18·2 | 78·5 | 77·0 | ·890 | 75 | 133·8 | 76·2 | 153 | 20 | S.W. | 5·39 | 18 | 18 | 131·9 | |
| September . | ·773 | ·128 | 84·7 | 94·5 | 78·4 | 16·1 | 79·2 | 75·4 | ·921 | 77 | 138·9 | 77·1 | 128 | 16 | S. | 1·36 | 5 | 47 | 158·2 | |
| October .. | ·846 | ·116 | 82·1 | 90·2 | 75·8 | 14·4 | 77·5 | 74·8 | ·882 | 81 | 133·8 | 74·4 | 113 | 5 | N.E. by E. | 11·00 | 12 | 53 | 164·4 | |
| November .. | ·911 | ·103 | 78·0 | 85·3 | 72·3 | 13·0 | 74·5 | 71·6 | ·813 | 85 | 128·8 | 70·9 | 142 | 4 | N.E. | 21·81 | 18 | 49 | 156·1 | |
| December .. | 30·007 | ·114 | 75·2 | 83·4 | 68·4 | 15·0 | 70·1 | 67·2 | ·667 | 76 | 130·1 | 65·4 | 162 | 2 | N.N.E. | 0·30 | 2 | 34 | 200·1 | |
| Annual .. | 29·844 | 0·120 | 82·4 | 91·9 | 75·6 | 16·3 | 76·6 | 73·8 | 0·843 | 76 | 134·3 | 73·5 | 152 | 12 | S.E. | 46·69 | 78 | 34 | 2,347·9 | |

## Extreme Monthly Meteorological Records at the Madras Observatory in 1912.

| Months. | Barometer. | | | | | Dry bulb thermometer. | | | | Wet bulb. | | Humidity. | | Sun Th. *in vacuo.* | | Grass therm. | | Wind. | | | | Rain. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | | Lowest. | | Range. | Highest. | | Lowest. | | Lowest. | | Lowest. | | Highest. | | Lowest. | | Highest. | | Lowest. | | Greatest fall. | |
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY. |
| January .. | 30·184 | 19 | 29·913 | 13 | 0·271 | 87·1 | 13 | 60·5 | 4 | 60·5 | 4 | 50 | 7 | 137·5 | 31 | 54·9 | 10 | 169 | 17 | 49 | 26 | 1·47 | 15 |
| February .. | ·086 | 1 | ·798 | 25, 29 | ·288 | 89·3 | 28 | 66·5 | 26 | 65·7 | 26 | 56 | 24 | 135·3 | 13 | 62·8 | 26 | 152 | 10, 11 | 78 | 15 | .. | .. |
| March .. | ·048 | 10 | ·718 | 29 | ·330 | 94·9 | 22 | 68·3 | 17 | 67·9 | 17 | 43 | 8 | 139·9 | 2 | 64·4 | 2 | 272 | 29 | 97 | 16 | .. | .. |
| April .. | ·044 | 12 | ·704 | 30 | ·340 | 97·2 | 30 | 72·5 | 3 | 71·8 | 3 | 51 | 29 | 141·8 | 30 | 69·6 | 3 | 210 | 21 | 127 | 18 | .. | .. |
| May .. | 29·930 | 4 | ·564 | 17, 19 | ·366 | 111·6 | 19 | 76·4 | 1 | 72·9 | 1 | 40 | 24 | 148·3 | 20 | 75·5 | 1 | 323 | 16 | 131 | 9 | .. | .. |
| June .. | ·804 | 7 | ·529 | 29 | ·275 | 108·2 | 2 | 74·9 | 20 | 74·1 | 29 | 41 | 18 | 147·6 | 16 | 74·9 | 20 | 270 | 29 | 167 | 26 | 1·41 | 19 |
| July .. | ·815 | 30 | ·522 | 28 | ·293 | 102·8 | 30 | 75·2 | 20 | 72·1 | 23 | 34 | 29, 30 | 145·4 | 30 | 74·5 | 20 | 270 | 27 | 88 | 14 | 0·89 | 19 |
| August .. | ·865 | 13 | ·565 | 27 | ·300 | 102·1 | 5 | 72·1 | 25 | 72·1 | 25 | 41 | 15 | 144·8 | 5 | 72·1 | 25 | 191 | 8 | 120 | 30 | 1·69 | 21 |
| September .. | ·916 | 9 | ·565 | 5 | ·351 | 99·7 | 1 | 71·1 | 17 | 71·1 | 17 | 56 | 6 | 149·2 | 16 | 72·7 | 17 | 175 | 7 | 51 | 22 | 0·86 | 17 |
| October .. | ·964 | 11 | ·690 | 30 | ·274 | 98·3 | 7 | 68·6 | 31 | 66·4 | 31 | 56 | 8 | 147·4 | 7, 11 | 65·4 | 31 | 211 | 17 | 50 | 22 | 2·92 | 20 |
| November .. | 30·007 | 29, 30 | ·789 | 1 | ·218 | 92·2 | 1 | 67·6 | 10 | 66·8 | 10 | 58 | 10 | 140·2 | 4 | 70·0 | 11 | 273 | 19 | 63 | 22 | 4·05 | 13 |
| December .. | ·107 | 14 | ·878 | 19 | ·229 | 84·8 | 23, 29 | 63·9 | 26 | 63·5 | 26 | 54 | 23 | 138·4 | 18 | 60·5 | 26 | 273 | 14 | 82 | 25 | 0·21 | 13 |

# ANNUAL REPORT

OF THE

# DIRECTOR

# KODAIKANAL AND MADRAS

# OBSERVATORIES

# FOR 1913.

MADRAS:

PRINTED BY THE SUPERINTENDENT, GOVERNMENT PRESS.

1914.

# KODAIKANAL AND MADRAS OBSERVATORIES.

## REPORT FOR THE YEAR 1913.

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# KODAIKANAL AND MADRAS OBSERVATORIES.

## I. REPORT OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1913.

*Staff.*—The staff of the observatory on December 31, 1913, was as follows:—

| | |
|---|---|
| Director ... ... ... ... | J. Evershed (on deputation to New Zealand). |
| | T. Royds, D.Sc. (officiating). |
| Assistant Director ... ... ... | T. Royds, D.Sc. |
| First Assistant ... ... ... | S. Sitarama Ayyar, B.A. |
| Second Assistant ... ... ... | G. Nagaraja Ayyar. |
| Third Assistant ... ... ... | A. A. Narayana Ayyar, B.A. |
| Fourth Assistant ... ... ... | S. Balasundaram Ayyar (on furlough). |
| | S.N. Krishna Ayyar (acting). |
| Writer ... ... ... ... | L. N. Krishnaswami Ayyar. |
| Photographic Assistant ... ... | R. Krishna Ayyar. |

The Director was on privilege leave for three months from August 4, and his services were lent to the New Zealand Government for three months from December 11, to advise relating to a proposed Solar Observatory and to select a site. The Assistant Director officiated as Director on both occasions. The First, Second, and Photographic Assistants were on privilege leave for 32 days, 6 weeks, and 1 month from September 15, July 23, and October 20, respectively. Mr. S. Balasundaram Ayyar is on combined privilege leave and furlough for nine months from July 1.

Mr. A. V. Subrahmanya Ayyar, B.A., resigned his appointment as Third Assistant on February 8, and Mr. A. A. Narayana Ayyar, B.A., of the Madras Observatory was appointed in his place on probation for six months.

The Subordinate staff consists of a book-binder, an assistant book-binder, a mechanic, five peons, a boy peon for the dark room and two lascars.

2. *Distribution of work.*—The Director and the Assistant Director have charge of the two spectroheliographs and the large grating spectrograph. The First, Second, and Third Assistants are in charge of the work with the Cooke equatorial (spectroscopic), the Lerebour and Secretan equatorial (visual and photographic), and the transit instrument. They have also to do the astronomical computing and the preparation of the observations for the press. The Second and Third Assistants have been trained to measure spectrum plates and the Third Assistant has charge of the seismometer and clock comparisons. The meteorological work of the observatory has been reduced (*vide* section 13) and is done by the Fourth Assistant and the Writer. The Fourth Assistant also assists Mr. C. Michie Smith, C.I.E., retired Director of the Observatory in the preparation of a memoir on the meteorology of Periyakulam and Kodaikanal. The Writer is responsible for the accounts, correspondence, and all office records. The Photographic Assistant has charge of most of the photographic developing, printing, etc.

3. *Buildings and grounds.*—The buildings and grounds have been kept in good repair.

The question has been raised of transferring, either partially or wholly, the work of the observatory to Kashmir where the Director, whilst on leave, found the observing conditions more suitable than at Kodaikanal. Consequently the construction of a building for the Poona 20-inch reflecting telescope is held over for the present. It is expected that the Director will make a three months' expedition to Kashmir with suitable instruments for thoroughly testing the conditions in Kashmir both for solar and stellar work.

The fire lines in the compound have been kept in good order and there has been no trouble from forest fires during the year.

4. *Instruments.*—The following are the principal instruments belonging to the observatory, or in use, at the present time :—

Six-inch Cooke equatorial.
Six-inch Lerebour and Secretan equatorial remounted by Grubb, with a five-inch Grubb portrait lens attached. The Lerebour and Secretan object glass has been replaced by a Cooke photo-visual lens of the same aperture and the instrument has been adapted for direct solar photography in addition to visual work.
Spectrograph I—consisting of slit, collimator lenses of 4 and 7 feet focus, 2-inch parabolic grating, and camera tube without lens. Used in connection with an 11-inch polar siderostat and 6-inch Grubb lens of 40 feet focus.
Spectrograph II—consisting of a collimator of 7 feet focus and camera of 14 feet focus placed at an angle of 60° with the former. Plane gratings of 3¼ inches or 5 inches ruled surface are used, and the slit is provided with various devices for the direct comparison of spectra from different sources, and for rotating the solar image.
Spectroheliograph—with 18-inch siderostat and 12-inch Cooke photo-visual lens of 20 feet focus, by the Cambridge Scientific Instrument Company.
An auxiliary spectroheliograph attached to the above, made in the Observatory workshop.
Six-inch transit instrument and barrel chronograph, formerly the property of the Survey of India.
Theodolite, six-inch—Cooke.
Sextant.
Evershed spectroscope with three prisms, for prominence and sunspot work, by Hilger.
Mean time clock, Kullberg 6326.
Do. Shelton.
Mean time chronometer, Kullberg 6299.
Sidereal chronometer, Kullberg 6134.
Tape chronograph, Fuess.
Two micrometers for measuring spectrum photographs, Hilger.
Hartmann Photometer.
Dividing engine, Cambridge Scientific Instrument Company, Limited.
Milne horizontal pendulum seismograph.
Induction coil with necessary adjuncts.
Small polar siderostat.
Universal instrument.
Complete set of meteorological instruments, including a Richard thermograph and a new Richard weekly barograph.
A high class screw cutting turning lathe by Messrs. Cooke & Sons.
Angström Pyrheliometer.
An 18-inch concave mirror by Henry of Paris belonging to the Director is mounted in the spectroheliograph room for general spectrum work.

The instruments received from the Takhtasinghji Observatory at Poona include the following :—

Twenty-inch reflecting telescope, by Common.
Six-inch Cooke photo-visual telescope with equatorial mounting.
Two prisms of 6 inches aperture for use with the above.
Twelve-inch Cooke siderostat.
Eight-inch horizontal telescope.
Large grating spectroscope, by Hilger.
An ultra-violet spectrograph by Grubb.
Sidereal clock, Cooke.
Mean time chronometer, Frodsham No. 3476.

# OBSERVATIONS.

## (a) SOLAR PHYSICS.

5. The following table shows for each day the solar observations that were made:—

### *Table A.*

Solar Observations in 1913.

A = Disc examined. B = Spot spectrum observed. C = Prominences observed. D = Photoheliograms taken. E = Spectroheliograms taken

| Dates. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 ... | A—*C* D E | A—C D E | A—C D E | A—C D E | A—C D E | A—C D E | A—*C* D E | A—*C* D E | A—*C* D E | A— —D E | — — — — | A—C D E |
| 2 ... | A—*C* D E | A—*C* D E | A—*C* D E | A—C D E | A—C D E | A—*C* D E | A— —D E | A—C D E | A—C D E | A—*C* D E | A—C D E | A—*C* D E |
| 3 ... | A—C D E | A—C D E | A—C D E | A—*C* D E | A—*C* D E | A — D — | A—C D E | A—*C* D E | A—C D E | A— —D E | A — — — | A— —D E |
| 4 ... | A—C D E | A—C D E | A—*C* D E | A—C D E | A—C D E | — — — — | A—*C* D E | A—*C* D E | A—C D E | A—*C* D E | A—C D E | A— —D— |
| 5 ... | A—C D E | A—C D E | A—C D E | A—C D E | — — — *E* | A—C D *E* | A — —D | A—*C* D E | A—C D E | A—C D E | A—C D E | A—*C* D E |
| 6 ... | A—C D E | A—C D E | A—*C* D E | A—C D E | A—C D E | A — D — | A—*C* D E | A—*C* D E | A—*C* D E | A—C D E | A—C D E | A—C D E |
| 7 ... | A—C D E | A—C D E | A—*C* D E | A—C D E | A—*C* D E | — — — — | A—*C* D E | A—*C* D E | A—*C* D E | A—C D E | — — — — | — — — — |
| 8 ... | A—C D E | A—C D E | A—C D E | A—C D E | A—C D E | A—C D E | A—*C* D E | A—C D E | A—*C* D E | A—*C* D E | A — — — | A — — — |
| 9 ... | A— —D— | A—C D E | A—C D E | A—C D E | A—C D E | A—*C* D E | A—C D E | A—C D E | A—C D E | A— —D *E* | — — — — | A—*C* D E |
| 10 ... | A — — — | A—C D E | A—*C* D E | A—C D E | A—*C* D E | A—C D E | A—C D E | A—*C* D E | A—C D E | A—*C* D E | — — — — | A—*C* D E |
| 11 ... | A—*C* D E | A—C D E | A—*C* D E | A—C D E | A—*C* D E | A—*C* D E | A—*C* D E | A—C D E | A—*C* D E | A — — E | A—*C* D *E* | A— —D E |
| 12 ... | A—C D E | A—*C* D E | A—*C* D E | A—C D E | A—C D E | A—*C* D E | A—C D E | A—C D E | A — D E | A—*C* D E | A—C D E | A—*C* D E |
| 13 ... | A—C D E | A—C D E | A—*C* D E | A—C D E | A—C D E | A—*C* D E | A— —D E | A— —D E | A— — *E* | A—C D E | A— —D E | A—C D E |
| 14 ... | A—C D E | A—*C* D *E* | A—C D E | A—*C* D E | A—C D E | A—C D E | A— —D E | A—*C* D E | A— —D *E* | A—*C* D E | A—C D E | A—*C* D E |
| 15 ... | A— —D *E* | A—*C* D E | A—*C* D E | A—C D E | A—C D E | A—*C* D E | A—C D E | A—*C* D E | A—C D E | A—C D E | A—C E E | A—C D E |
| 16 ... | A—C D E | A—*C* D E | A—C D E | A—*C* D E | A—C D E | A—*C* D E | — — — — | A—*C* D E | A—C D E | A—C D E | A—*C* D E | — — — — |
| 17 ... | — — — — | A—C D E | A—C D E | — — — — | A—*C* D E | A—*C* D E | A — — — | A—*C* D E | A—C D E | A—C D E | A—C D E | — — — — |
| 18 ... | — — — — | A—C D E | A—C D E | A—*C* D E | A—C D E | A — D *E* | A— —D *E* | A— —D *E* | A—*C* D E | A—C D E | A—C D E | — — — — |
| 19 ... | A—*C* D E | A—C D E | A—C D E | A—*C* D E | A—C D E | A — D *E* | A—*C* D E | A— —D *E* | A—C D E | A—*C* D E | A—C D E | A—C D E |
| 20 ... | A—C D E | A—C D E | A—*C* D E | A—C D E | A—*C* D E | A—C D E | A— —D *E* | A—C D E | A—*C* D E | — — — — | A—C D E | A—C D E |
| 21 ... | A—C D E | A—C D E | A—C D E | A—*C* D E | A— —D E | A— —D— | A—*C* D E | — — — — | A—C D E | A—C D E | — — — E | — — — — |
| 22 ... | A—C D E | A—*C* D E | A—C D E | A—*C* D E | A—C D E | A—*C* D E | A—*C* D E | A—*C* D E | A—C D E | A—C D E | A—*C* D E | A—*C* D E |
| 23 ... | A—C D E | A — — E | A—*C* D E | A—C D E | A—C D E | A—C D E | A—*C* D *E* | A—C D E | A—*C* D E | A— —D— | A—C D E | A—C D E |
| 24 ... | A— —D *E* | A—*C* D E | A—C D E | A—*C* D E | — — — *E* | A—*C* D E | A—C D E | A—*C* D E | A— —D *E* | A—*C* D E | A—C D E | A—C D E |
| 25 ... | A—*C* D E | A— —D E | A—C D E | A—*C* D E | A—C D E | A—*C* D E | A—C D E | A—*C* D E | A—*C* D E | — — — — | A—*C* D E | A—C D E |
| 26 ... | A—C D E | A—*C* D E | A—*C* D E | A—C D E | A—C D E | A—*C* D E | A—*C* D E | A—*C* D E | A — D E | A — — — | — — — — | A—C D E |
| 27 ... | A— —D E | A—C D E | A—C D E | A—*C* D E | A—*C* D E | A—*C* D *E* | A—C D E | — — — — | A—*C* D E | A — D — | A — — — | A—C D E |
| 28 ... | A—C D E | A—*C* D E | A—C D E | A—C D E | A—*C* D E | A—*C* D E | A—C D *E* | A—*C* D E | A—*C* D E | A—C D E | — — — — | A—C D E |
| 29 ... | A—C D E | | A—*C* D E | A—*C* D E | A—*C* D E | A—*C* D E | A— — — | A—C D E | A—C D E | A— —D *E* | — — — — | A—*C* D E |
| 30 ... | A—C D E | | A—C D E | A—*C* D E | A—*C* D *E* | A—C D E | A— —D *E* | A—*C* D E | A—*C* D *E* | A—C D E | A—*C* D E | A—*C* D *E* |
| 31 ... | A—C D E | | A—C D E | | A—*C* D E | | — — — — | A—C D E | | A— —D— | | A—*C* D E |

*Note.*—When a letter is in italics, it means that on that day the observation was not complete.

Solar Observations—Abstract.

| | 1913. | | | | | | | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | January | February. | March. | April. | May. | June | July. | August. | September. | October. | November | December. | |
| A | 29 | 28 | 31 | 29 | 29 | 28 | 29 | 29 | 30 | 29 | 22 | 26 | 339 |
| B | .. | .. | ... | .. | ... | ... | ... | ... | .. | ... | ... | ... | .. |
| C | 24 | 26 | 31 | 29 | 28 | 23 | 20 | 26 | 25 | 20 | 18 | 22 | 292 |
| D | 28 | 27 | 31 | 29 | 29 | 28 | 27 | 29 | 29 | 27 | 19 | 25 | 328 |
| E | 27 | 28 | 31 | 29 | 31 | 26 | 26 | 29 | 30 | 25 | 19 | 24 | 325 |

The partial failure of the monsoon in this locality in 1913 shows itself as an increase in the number of days of observation in the above table. During the months June to October the sun was examined for spots and faculæ on 145 days against 135 in 1911 and 120 in 1912; but the number of days for the whole year is not very high.

6. *Photoheliograph.*—Photographs of the sun were obtained on 328 days as against 329 in 1912. The number of possible days was very low in November. The photographs are, as stated in the last report, taken with the photo-visual telescope in the north dome. Double exposures are taken twice a month for determining the error of orientation of the photographs. Six solar negatives asked for by the Greenwich Observatory to complete their series for the period January to June 1913 were all sent.

7. *Spectroheliograph.*—Monochromatic photographs of the sun's disc in "K" light were taken on 325 days, and prominence plates on 300 days. With the autocollimating spectroheliograph H$\alpha$ images were secured on 202 days. The prominence plates are measured as soon as obtained, and the results tabulated. Duplicates of the disc plates have been sent to the Cambridge Observatory for measurement since the South Kensington Observatory was transferred there.

The Michelson grating in the H$\alpha$ spectroheliograph was removed on November 20 for use in the spectrograph.

8. *Grating Spectrograph.*—The work with the spectrograph has been mainly along the following lines :—(1) comparison of the centre and the limbs of the sun ; (2) comparison of the sun's centre and the iron arc in air and *in vacuo* ; (3) comparison of the sun's limb and the iron arc. These comparisons were used to investigate the equatorial velocity of rotation of the sun, and the study of the displacements of the lines of the sun's centre and limb. Mr. Evershed has now put forward the view that these displacements can be best explained as due to velocities in the line of sight rather than to pressure which has been hitherto the commonly accepted explanation (*see* Bulletin No. XXXVI). These investigations are being continued, special regard being paid to those lines of which we know the effective levels, as well as their behaviour under pressure.

A new method of measuring spectrum plates has been worked out by the Director.

9. 6-*inch Cooke Equatorial and Spectroscope.*—As stated in section 9 of the last report the old Cooke equatorial telescope with its mounting and also the Evershed spectroscope were removed from the south dome and re-erected in the photoheliograph dome in October 1912. Visual spectroscopic observations were made there from October 15, 1912, to March 26, 1913. On March 27 the Evershed Spectroscope was replaced by a new grating spectroscope constructed by the Director. Meanwhile the 6-inch

Cooke Equatorial with the Hilger Solar Spectroscope, both from Poona, were erected in the south dome and a series of comparative observations with this combination and that of the old Cooke telescope with the new grating spectroscope showed the former combination to be a better instrument; it was accordingly adopted for regular observations from April 4, 1913. A careful examination of the sun's limb is made for displacements of hydrogen lines and for metallic prominences. A fairly large number of the former have been recorded.

Prominences were recorded visually on 292 days. There was no spot large enough to have its spectrum observed in detail, except perhaps one which was seen early in December, but the weather was unfavourable on the only two days on which the spot was fairly large. Disturbances in the C line were recorded on about half-a-dozen days and $D_3$ was observed as an absorption line on one day.

*Summary of Sunspot and Prominence Observations.*

10. *Sunspots.*—The following table shows the monthly numbers of new groups observed, the mean daily numbers of spots visible, and the distribution between the northern and southern hemispheres :—

| — | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups ... ... | 3 | 1 | 2 | 1 | ... | ... | 1 | ... | 1 | 2 | 1 | 4 | 16 |
| Daily number ... | 0·3 | 0·4 | 0·1 | 0·1 | ... | ... | 0·2 | ... | 0·1 | 0·3 | 0·1 | 0·5 | 0·2 |
| North ... ... ... | 1 | 1 | ... | ... | ... | ... | 1 | ... | 1 | 2 | ... | 1 | 7 |
| South ... ... ... | 2 | ... | 2 | 1 | ... | ... | ... | ... | ... | ... | 1 | 3 | 9 |
| Equator ... ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

It was stated in the last report that the new cycle of spot activity could probably be considered to have begun about the end of 1912. There seemed to be some confirmation of this in the early months of 1913, especially as the spot of February which was a high latitude one, 32° north, lived long enough to pass across the whole disc of the sun; but the activity was not kept up as the year advanced. In fact there were three months—May, June, and August—without a single spot recorded as against two months in 1912; also only 16 spot groups were recorded in the whole year, which is six less than in 1912. On the other hand the average latitude was high (19°·9 north and 16°·9 south) in 1913 as compared with previous years, which is an indication of the commencement of a new cycle. Further, on December 13, 1913, three separate spot groups were seen on the disc, for the first time since May 1911. The distribution of spots between the two hemispheres was more even than in former years, there having been seven northern spots and nine southern.

The following particulars may be useful for comparing the spot activity of recent years :—

| — | 1910. | 1911. | 1912. | 1913. |
|---|---|---|---|---|
| Number of new groups ... | 152 | 56 | 22 | 16 |
| Mean daily numbers ... | 1·8 | 0·7 | 0·3 | 0·2 |
| Number of days on which no spot was seen. | 56 | 158 | 240 | 288 |

Only two spots, one in February and the other in December, reached a fair size, but neither of them could be called large.

11. *Prominences.*—The mean prominence areas in the years 1912 and 1913 are given below :—

*Mean daily Profile areas of Prominences in square minutes of arc.*

| — | 1912. | 1913. |
|---|---|---|
| North ... ... ... ... | 0·95 | 1·08 |
| South .. ... ... ... | 1·51 | 1·11 |
| Total ... | 2·46 | 2·19 |

The mean area for 1913 was 93·1 per cent. of that of the previous year, the figures for 1912 and 1911 being 84·5 and 71·0 per cent., respectively, showing that the decrease in prominence activity is now becoming slower.

The distribution in latitude in 1913 was very much the same as in 1912, the only noticeable differences being that the secondary maximum in the southern hemisphere between 15° to 20° found in the latter half of 1912 has disappeared, and the region of greatest activity—between latitude 40° and 50°—shows a tendency to broaden towards the equator.

*Metallic Prominences.*

| — | Number observed. | Mean latitude. | Extreme latitudes. | |
|---|---|---|---|---|
| North ... ... ... | 2 | 26° | 25°·5 | 26°·0 |
| South ... ... ... | 3 | 44° | 41°·5 | 46°·[illegible] |

The prominence activity in each month may be estimated from the following table :—

*Number of Prominences.*

| Months. | Prominences one minute or more in height. | Metallic. | Eruptive. |
|---|---|---|---|
| January ... ... ... ... | 55 | 2 | 5 |
| February ... ... ... | 68 | ... | 4 |
| March ... ... ... ... | 80 | 3 | 2 |
| April ... ... ... ... | 62 | ... | 4 |
| May ... ... ... ... | 46 | ... | 1 |
| June ... ... ... ... | 23 | ... | 1 |
| July ... ... ... ... | 23 | ... | 1 |
| August ... ... ... ... | 22 | ... | ... |
| September ... ... ... | 18 | ... | ... |
| October ... ... ... ... | 17 | ... | ... |
| November ... ... ... | 25 | ... | ... |
| December .. ... ... | 21 | ... | 1 |

The reduction in the number of "large" prominences since 1912 is about the same as that in the mean profile areas.

Only five metallic prominences were recorded : two of these were observed on the same day within 3° of each other and probably originated in a common disturbance.

## (*b*) Other Observations.

12. *Time.*—The error of the standard clock is usually determined by reference to the 16-hour signal from the Madras Observatory. This is rendered possible by the courtesy of the Telegraph department which permits the Madras wire to be joined through to this observatory. The signal is received with accuracy on most days and all failures are at once reported to the officer in charge of the Trichinopoly division. Independent time determinations have been made with the transit instrument using the Sidereal chronometer K 6134.

13. *Meteorology.*—Eye observations are made at $8^h$, $10^h$ and $16^h$ local mean time as in former years. The Richard thermograph (wet and dry bulb) and barograph, the Beckley anemograph, and the sunshine recorder also continue in use. The Beckley anemograph was out of action from March 23 to July 28 during the repairs to the wind tower. The tabulation of the hourly readings from the barograms, thermograms and sunshine records has been stopped since March and the anemograms are now tabulated by the Madras Observatory staff which also prepares the $8^h$ register from readings taken here. The preparation of the $10^h$ and $16^h$ registers is done in the Calcutta Meteorological Office. The wind velocity and direction for the daily weather telegrams to Simla and Madras are obtained as usual from the Robinson anemometer and a wind vane. From the 8th December a weekly Richard barograph has been substituted for the daily one which was formerly in use.

*Pressure.*—The average pressure for the year was 0·006 inch above the normal ; half of the excess is due to the pressure being 0·035 inch above normal in December. The monthly mean pressure was below normal from March to June and above in the other months ; the greatest defect was 0·017 in June.

*Temperature.*—The monthly mean temperature was in excess of the normal throughout the year and the mean maximum was in excess in the first ten months of the year. The monthly mean dry minima did not vary much from the normal so that there was a wider range of temperature than usual. The annual mean temperature, the annual mean maximum temperature and the annual mean range were respectively 2°·2, 1°·4 and 1°·5 above normal. The mean "sun maximum" was also in excess in every month except November.

*Humidity.*—The annual mean was in defect of the normal by two per cent. and the mean did not vary much from the normals in the individual months but the variations were the reverse of the temperature variations, that is, they were in defect from January to October and in excess in November and December.

*Rainfall.*—The total annual fall was 3·27 inches below normal and the number of rainy days was less by nine. The distribution was also abnormal. In the eight months January, February, April, May, June, August, September and October there was a total defect of 14·28 inches and in the other four months a total excess of 11·01 inches. The greatest deviation from normal was a defect of 5·23 inches in October.

*Transparency of the atmosphere.*—The transparency of the lower atmosphere as judged by the visibility of the Nilgiris, about 100 miles distant, was again much below normal being even worse than in the years 1911 and 1912.

*Cloud and Sunshine.*—The annual mean clear sky was practically the same as the normal but there was the great excess of 327·5 hours above normal in the total duration of bright sunshine.

14. *Seismology.*—The Milne horizontal pendulum recorded only 61 earthquakes as against 81 in 1912. The number of large shocks was also smaller but the largest, recorded on January 19, had a greater amplitude than any in 1912.

15. *Library.*—One hundred and fifty volumes were bound during the year. A new catalogue of the library is in preparation.

16. *Publications.*—Seven Bulletins, Nos. XXVII to XXXIII were published during the year, and Nos. XXXIV to XXXVI were in the press at the end of the year. Their titles are as follows :—

No. XXVII.—On the Presence of Radium and the elements of the inactive group in the Chromosphere, by J. Evershed.

No. XXVIII.—On the relative numbers of Prominences observed on the Eastern and Western limbs, by J. Evershed.

No. XXIX.—Summary of Prominence observations for the first half of the year 1912, by J. Evershed.

No. XXX.—Summary of Prominence observations for the second half of the year 1912, by J. Evershed.

No. XXXI.—Summary of Prominence observations for the first half of the year 1913, by J. Evershed.

No. XXXII.—A new method of measuring small displacements of spectrum lines, by J. Evershed.

No. XXXIII.—Prominence Periodicities, by T. Royds.

No. XXXIV.—A comparison of the Periodicities in Prominences and Sunspots, by T. Royds.

No. XXXV.—The apparent effect of planets on the distribution of Prominences, by T. Royds and S. Sitarama Ayyar.

No. XXXVI.—A new Interpretation of the general displacement of the lines of the solar spectrum towards the red, by J. Evershed.

The following contributions were made in addition to the above :—

The Determination of Ancient dates from Astronomical data, by T. Royds and S. Sitarama Ayyar. *Astronomical Society of India.*

The distribution in latitude of dark $H_\alpha$ markings, by T. Royds. *Monthly Notices of the Royal Astronomical Society.*

Some spectrographic measures of the Solar Rotation made at the Kodaikanal Observatory, by J. Evershed and T. Royds. *Monthly Notices of the Royal Astronomical Society.*

A new method of estimating changes in the general radiation of the sun, by J. Evershed. Read at the *International Solar Union*, at Bonn in August 1913.

Report on sunspot spectra (a summary of the visual and photographic work done at Kodaikanal during the years 1910, 1911 and 1912), by J. Evershed. Read at the *International Solar Union* at Bonn in August 1913.

17. *General.*—The Director-General of Observatories inspected the Kodaikanal Observatory in February and the Director inspected the Madras Observatory in November.

The staff of the Observatory has worked well during the year ; Messrs. S. Sitarama Ayyar, First Assistant, and R. Krishna Ayyar, Photographic Assistant, deserve special mention for their zeal and industry.

T. ROYDS,
*Offg. Director, Kodaikanal and Madras Observatories.*

THE OBSERVATORY, KODAIKANAL,
*19th February* 1914.

# II. REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1913.

*Staff.*—The Staff at the Observatory on December 31, 1913, was as follows :—

| | |
|---|---|
| Deputy Director ... ... ... ... | R. Ll. Jones. |
| Computer ... ... ... ... ... | S. Solomon Pillai. |
| First Assistant ... ... ... ... | C. Chengalvaraya Mudaliyar. |
| Second Assistant ... ... .. ... | E. Ramanujam Pillai. |

Two peons and two lascars form the subordinate staff. The Deputy Director was absent on leave from 4th April to 30th November 1913. Mr. J. L. Simonsen was in charge from 4th April to 27th June 1913 and Mr. R. Littlehailes from 28th June to 30th November 1913. Mr. A. A. Narayana Ayyar, First Assistant, was transferred to the Kodaikanal Observatory and his place was filled by Mr. C. Chengalvaraya Mudaliyar of the Madras Meteorological office. Mr. E. Ramanujam Pillai was absent on privilege leave for three months from 23rd June 1913.

2. *Time Service.*—No change has been made in the methods for determining time or in the time service. The firing of the 8 P.M. gun at the Fort was resumed from 1st January 1913. The Fort gun failed on nine occasions and fired correctly on 721 occasions out of 730, giving 98·8 as the percentage of success. The failures were due to faults outside the Observatory.

The Semaphore at the Port office failed on three occasions and was dropped correctly at 1 P.M. every other day ; on two of the occasions on which it failed at 1 P.M., it was dropped correctly at 2 P.M.

The Post office clock, which has hitherto been under the control of the Observatory, was handed over to the Telegraph Department at their request, on 1st April 1913. It was electrically connected with the Observatory Standard clock on 8th May 1913.

3. *Meteorological Observations.*—In addition to the ordinary meteorological observations, extra observations were taken for storm warning purposes and telegrams sent to Simla on one occasion and to Calcutta on 49 occasions. The solar radiation thermometer in use was broken by accident on 20th December 1913 and a new one has been applied for.

4. *Buildings.*—The usual annual repairs to the office and quarters were carried out during the year. No examination of the foundations of the transit instrument was made during the year, owing to the absence of the Deputy Director on leave.

5. *Instruments.*—The following is a list of the instruments at the Observatory on the 31st December 1913 :—

(a) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton & Simms.
Sidereal Clock—Haswall.
Do. Dent, No. 1408.
Do. S. Riefler, No. 61.
Mean Time Clock—J. H. Agar Baugh, No. 105.
Do. with galvanometer—Shepherd & Sons.
Meridian Circle—Troughton & Simms.
Mean Time Chronometer—V. Kullberg, No. 5394.
Do. do. No. 6544.
Portable Transit Instrument—Dolland.
Portable Telescope with stand.
Tape Chronograph—R. Fuess.
Relay for use with the Chronograph—Siemens.

(b) *Meteorological.*

Richard's Barograph—No. 10, L. Casella.
Do. Thermograph—No. 29637, L. Casella.
Beckley's Anemograph—Adie.
Sunshine Recorder—No. 149, L. Casella.
Nephoscope—Mons Jules Daboseq & Ph. Pellin.
Barometer, Fortin's—No. 1771, L. Casella.
Do. No. 725, L. Casella (spare).
Do. No. 1420, L. Casella (spare).
Dry Bulb Thermometer—No. 94221, L. Casella.
Do. No. 38037, Negretti & Zambra (spare).
Wet Bulb Thermometer—No. 94219, L. Casella.
Do. No. 38037, Negretti & Zambra (spare).
Dry Maximum Thermometer—No. 8581, Negretti & Zambra.
Dry Minimum Thermometer—No. 69017, L. Casella.
Wet Minimum Thermometer—No. 91753, Negretti & Zambra.
Grass Minimum Thermometer—No. 3377, Negretti & Zambra.
Raingauge (8″ diameter)—No. 1042, Negretti & Zambra.
Measure glass for above.
Raingauge (5″ diameter).
Measure glass for above.

The Chronograph, Chronometer, Kullberg No. 6544, Barograph and the Mean Time clock by Agar Baugh were cleaned during the year.

Large changes still take place in the level of the transit instrument and these changes were, as in previous years, closely associated with the rainfall.

During the visit of the Director in November the transit instrument was overhauled and the north collimator rewired and readjusted.

6. *Weather Summary.*—The following is a summary of the meteorological conditions at Madras during 1913 :—

*Pressure.*—Pressure was above normal in January, September, November and December and below normal in all the other months. The greatest excess was 0·024 inch in November and December and the greatest defect 0·036 inch in March. The highest pressure recorded was 30·257 inches on December 30 and the lowest 29·499 inches on June 6.

*Temperature.*—The mean temperature of air was above normal in all months except in October when it was normal. The highest shade temperature recorded was 107°·7 on May 12 and the lowest 63°·1 on January 14. The highest temperature in the sun was 148°·6 on September 10 and the lowest on grass 59°·4 on January 14.

*Humidity.*—Humidity was normal in January, below normal in March, June and August and above normal in the remaining months.

*Wind.*—The wind direction was normal in February and April. It was more northerly than usual in January and October, more southerly in March, May, June, July and September, more westerly in August and more easterly in the last two months. The wind velocity was below normal in all months except in January, April, August and November. In December the mean daily velocity was 26 miles below the average.

*Cloud.*—The percentage of cloud was normal in December, above normal in February and November and below normal in the remaining months.

*Sunshine.*—The bright sunshine recorded was above normal in March, April, August and September and below normal in the other months.

*Rainfall.*—The rainfall was above the average for May and the last three months in the year, and below normal for the other months ; the greatest excess was 17·28 inches in October and the greatest defect 3·84 inches in August. The total fall for the year was 65·05 inches against an average of 49·02 inches. The monsoon rainfall from October 15 to the end of the year was 48·16 inches against an average of 26·00 inches. The heaviest fall on any day was 8·19 inches on November 10.

THE OBSERVATORY, MADRAS,
26*th January* 1914.

R. LL. JONES,
*Deputy Director.*

# APPENDIX I.

## SEISMIC RECORDS.

## STATION—KODAIKANAL.

$\phi = 10^\circ\ 13'\ 50''$. $\lambda = 77^\circ\ 28'\ 00''$. $h = 2343\ m$ *Subsoil*—Rock.
*Apparatus*.—Milne Horizontal Pendulum.

| 1913. | | To | $\frac{r}{To^2}$ | 1913. | | To | $\frac{r}{To^2}$ |
|---|---|---|---|---|---|---|---|
| January | ... | 15·9 | 7·0 | July .. | ... | 16·5 | 2·9 |
| February | ... | 16·2 | 4·0 | August ... | ... | 16·7 | 2·8 |
| March ... | ... | 16·3 | 3·1 | September | ... | 16·7 | 2·8 |
| April ... | ... | 16·4 | 2·7 | October... | ... | 16·6 | 2·9 |
| May ... | ... | 16·3 | 3·0 | November | ... | 16·5 | 2·9 |
| June .. | ... | 16·4 | 2·9 | December | ... | 16·1 | 3·0 |

| No. | Date. | Phase. | Time G.M.T. H. | M. | Period. (Sec.) | Amplitude ($u$) An. | Ae. | Az. | Distance Δ (Km.) | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Jan. 1 ... | eP | 17 | 18·0 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 15 | 36·2 | ... | ... | .. | ... | ... | |
| 2 | 5 ... | iP | 17 | 42·4 | ... | ... | . | ... | ... | |
| | | eL | 17 | 54·4 | ... | ... | ... | .. | ... | |
| | | M | 18 | 01·7 | ... | | 60 | ... | ... | |
| | | F | 18 | 27·0 | ... | ... | ... | ... | ... | |
| 3 | 7 ... | eP | 23 | 12·4 | | ... | .. | ... | ... | |
| | | iL | 23 | 20·0 | ... | ... | ... | ... | ... | |
| | | M | 23 | 21·8 | ... | ... | 80 | ... | ... | |
| | | F | 23 | 41·3 | ... | ... | ... | ... | ... | |
| 4 | 9 ... | iP | 3 | 09·9 | ... | ... | ... | ... | ... | |
| | | eL | 3 | 23·3 | ... | ... | ... | ... | ... | |
| | | M | 3 | 26·1 | ... | ... | 40 | ... | ... | |
| | | F | 4 | 01·5 | ... | ... | ... | ... | ... | |
| 5 | 11 ... | iP | 13 | 25·6 | ... | ... | ... | ... | ... | |
| | | iL | 13 | 32·0 | ... | ... | ... | ... | ... | |
| | | M | 13 | 54·1 | ... | ... | 30 | ... | .. | |
| | | F | 15 | 51·5 | ... | ... | ... | ... | ... | |
| 6 | 13 ... | eP | 19 | 46·7 | ... | ... | ... | ... | ... | |
| | | eL | 19 | 47·9 | ... | ... | ... | ... | .. | |
| | | M | 19 | 52·0 | ... | ... | 60 | ... | ... | |
| | | F | 20 | 07·0 | ... | ... | ... | .. | ... | |
| 7 | 15 . | P | 20 | 30·0? | ... | .. | ... | ... | ... | Widening of line Hour signal at 20h 30.m. |
| | | F | 20 | 54·0 | ... | ... | ... | ... | ... | |
| 8 | 19 ... | eP | 17 | 09·5 | ... | ... | ... | ... | ... | |
| | | iL | 17 | 11·8 | ... | ... | ... | ... | ... | |
| | | M | 19 | 14·6 | ... | ... | 1,750 | ... | | |
| | | F | 19 | 54·0 | ... | ... | ... | ... | ... | |
| 9 | 19—20 ... | eP | 23 | 59·7 | ... | ... | . | ... | ... | Widening of line. |
| | | F | 0 | 52·6 | ... | ... | ... | ... | ... | |
| 10 | Feb. 11—12 ... | eP | 23 | 49·9 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 0 | 16·5 | ... | ... | ... | ... | ... | |
| 11 | 20 ... | eP | 9 | 10·0 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 9 | 56·0 | ... | ... | ... | ... | ... | |
| 12 | Mar. 4 ... | eP | 7 | 22·5 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 7 | 44·0 | ... | ... | .. | ... | .. | |
| 13 | 6 ... | eP | 2 | 16·9 | ... | ... | | ... | ... | |
| | | eL | 2 | 21·5 | ... | ... | ... | ... | ... | |
| | | M | 2 | 23·6 | ... | ... | 40 | ... | .. | |
| | | F | 2 | 38·2 | ... | ... | ... | ... | ... | |
| 14 | 6 ... | P | ... | | ... | ... | .. | ... | ... | No P. Ts. |
| | | iL | 11 | 11·5 | ... | ... | ... | ... | ... | |
| | | M | 11 | 14·3 | ... | ... | 50 | ... | ... | |
| | | F | 12 | 03·8 | ... | ... | ... | ... | ... | |
| 15 | 14 ... | iP | 8 | 54·9 | ... | ... | ... | ... | ... | |
| | | iL | 8 | 56·2 | ... | ... | ... | ... | ... | |
| | | M | 9 | 08·6 | ... | ... | 1,000 | ... | ... | |
| | | $M_2$ | | 22·5 | ... | ... | .. | ... | ... | |
| | | F | 12 | 37·2 | ... | .. | ... | ... | . | |
| 16 | 14 ... | eP | 18 | 11·5 | ... | ... | ... | ... | ... | |
| | | iL | 18 | 12·3 | ... | ... | ... | ... | ... | |
| | | M | 18 | 13·3 | ... | .. | 60 | ... | ... | |
| | | F | 18 | 23·6 | ... | ... | ... | ... | ... | |
| 17 | 23 ... | eP | 20 | 57·0 | ... | | ... | ... | ... | |
| | | iL | 21 | 06·8 | ... | . | ... | | ... | |
| | | M | 21 | 25·1 | ... | ... | 50 | ... | ... | |
| | | F | 22 | 01·0 | ... | ... | ... | ... | ... | |

Kodaikanal Observatory Seismic Records—*cont.*

| No. | Date. | Phase. | Time G.M.T. H. | M. | Period, (Sec.) | Amplitude ($u$) An. | Ae. | Az. | Distance △ (Km.) | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1913. | | | | | | | | | |
| 18 | Mar. 31 ... | eP | 4 | 05·0 | ... | .. | ... | ... | ... | |
| | | eL | 4 | 32·0 | ... | ... | ... | ... | ... | |
| | | M | 4 | 38·5 | ... | ... | 70 | ... | ... | |
| | | F | 6 | 39·9 | ... | ... | ... | ... | ... | |
| 19 | Apl. 7 ... | eP | 14 | 27·2 | ... | ... | ... | ... | ... | |
| | | F | 14 | 58·7 | ... | ... | ... | ... | ... | Widening of line. |
| 20 | 9 ... | eP | 18 | 20·3 | ... | ... | .. | ... | ... | |
| | | F | 19 | 19·7 | ... | ... | ... | ... | ... | Widening of line. |
| 21 | 13 . | eP | 7 | 02·0 | ... | ... | ... | ... | ... | |
| | | eL | 7 | 12·8 | ... | ... | ... | ... | ... | |
| | | M | 7 | 22·3 | ... | ... | 50 | ... | ... | |
| | | F | 7 | 59·7 | ... | ... | ... | ... | ... | |
| 22 | 18 ... | eP | 13 | 39·2 | ... | ... | ... | ... | ... | |
| | | iL | 13 | 43·1 | ... | ... | ... | ... | ... | |
| | | M | 13 | 43·6 | ... | ... | 20 | ... | ... | |
| | | F | 14 | 00·5 | ... | ... | ... | ... | ... | |
| 23 | 18 ... | eP | 19 | 10·7 | ... | ... | ... | ... | ... | |
| | | iL | 19 | 28·0 | ... | ... | ... | ... | ... | |
| | | M | 19 | 35·1 | ... | .. | 90 | ... | ... | |
| | | F | 20 | 09·2 | ... | ... | ... | ... | ... | |
| 24 | 24 ... | eP | 10 | 23·1 | ... | ... | ... | ... | ... | |
| | | iL | 10 | 41·2 | ... | ... | ... | ... | ... | |
| | | M | 10 | 50·6 | ... | ... | 110 | ... | ... | |
| | | F | 11 | 40·2 | ... | ... | ... | ... | ... | |
| 25 | 24 ... | iP | 12 | 35·4 | ... | ... | ... | ... | ... | |
| | | eL | 12 | 46·0 | ... | ... | ... | ... | ... | |
| | | M | 12 | 51·1 | ... | ... | 40 | ... | ... | |
| | | F | 13 | 26·4 | ... | ... | ... | ... | ... | |
| 26 | 25 ... | iP | 18 | 06·7 | ... | ... | ... | ... | ... | |
| | | iL | 18 | 14·8 | ... | ... | ... | ... | ... | |
| | | M | 18 | 31·0 | ... | ... | 300 | ... | ... | |
| | | F | 21 | 38·7 | ... | ... | ... | ... | ... | |
| 27 | 26 ... | eP | 4 | 17·8 | ... | ... | ... | ... | ... | |
| | | eL | 4 | 31·3 | ... | ... | .. | ... | ... | |
| | | M | 4 | 52·9 | ... | ... | 70 | ... | ... | |
| | | F | 5 | 37·1 | ... | ... | ... | ... | ... | |
| 28 | 30 ... | eP | 11 | 58·7 | ... | ... | ... | ... | ... | |
| | | iL | 12 | 30·0? | ... | ... | ... | ... | ... | |
| | | M | 12 | 34·6 | ... | ... | 50 | ... | ... | Hour signal at $12^h$ $30^m$. |
| | | F | 13 | 24·9 | ... | ... | ... | ... | ... | |
| 29 | May 7 ... | eP | | 12·0 | ... | ... | ... | ... | ... | |
| | | F | | 39·8 | ... | ... | ... | ... | ... | Widening of line. |
| 30 | 8 ... | eP | 18 | 54·7 | ... | ... | ... | ... | ... | |
| | | eL | 19 | 05·3 | ... | ... | ... | ... | ... | |
| | | M | 19 | 06·5 | ... | ... | 50 | ... | ... | |
| | | F | 20 | 37·0 | ... | ... | ... | ... | ... | |
| 31 | 16 ... | eP | 12 | 40·7 | ... | ... | ... | ... | ... | |
| | | F | 12 | 56·8 | ... | ... | ... | ... | ... | Widening of line. |
| 32 | 18 ... | eP | 2 | 20·7 | ... | ... | ... | ... | ... | |
| | | F | 3 | 40·2 | ... | ... | ... | ... | ... | Widening of line. |
| 33 | 30 ... | eP | 11 | 59·7 | ... | ... | ... | .. | ... | |
| | | iL | 12 | 09·2 | ... | ... | ... | ... | ... | |
| | | M | 12 | 39·7 | ... | ... | 100 | ... | ... | |
| | | | | 44·9 | ... | ... | 90 | ... | ... | |
| | | | | 53·1 | ... | ... | 90 | ... | ... | |
| | | F | 15 | 23·3 | ... | ... | ... | ... | ... | |
| 34 | June 4 ... | eP | 10 | 17·7 | ... | ... | ... | ... | ... | |
| | | eL | 10 | 25·9 | ... | ... | ... | ... | ... | |
| | | M | 10 | 44·9 | ... | ... | 50 | ... | ... | |
| | | $M_2$ | 10 | 57·2 | ... | ... | 50 | ... | ... | |
| | | F | 11 | 25·9 | ... | ... | ... | ... | ... | |
| 35 | 14 ... | eP | 9 | 50·7 | ... | ... | ... | ... | . | |
| | | iL | 10 | 06·7 | ... | ... | ... | ... | ... | |
| | | M | 10 | 15·4 | ... | ... | 120 | ... | ... | |
| | | F | 11 | 24·1 | ... | ... | ... | ... | ... | |
| 36 | 22 ... | eP | 14 | 14·0 | ... | ... | ... | ... | ... | |
| | | F | 16 | 45·4 | ... | ... | ... | ... | ... | Widening of line. |
| 37 | 26 ... | eP | 5 | 09·7 | ... | ... | ... | ... | ... | Instrument examined at $5^h$ $11^m$. |
| | | iL | 5 | 22·3 | ... | ... | ... | ... | ... | |
| | | M | 5 | 27·4 | ... | ... | 250 | ... | ... | |
| | | $C_1$ | 6 | 11·5 | ... | ... | 320 | ... | ... | |
| | | $C_2$ | 6 | 13·6 | ... | ... | 280 | ... | ... | |
| | | $C_3$ | 6 | 19·2 | ... | ... | 260 | ... | ... | |
| | | $C_4$ | 6 | 22·8 | ... | ... | 320 | ... | ... | |
| | | F | 8 | 56·7 | ... | ... | ... | ... | ... | |
| 38 | July 7 ... | eP | 17 | 55·6 | ... | ... | ... | ... | ... | |
| | | iL | 17 | 58·5 | ... | ... | ... | ... | ... | |
| | | M | 17 | 58·7 | ... | ... | 40 | ... | ... | |
| | | F | 19 | 03·9 | ... | ... | ... | ... | ... | |

Kodaikanal Observatory Seismic Records—*cont.*

| No. | Date. | | Phase. | Time. G.M.T. | | Period. (Sec.) | Amplitude (u) | | | Distance. △ (Km.) | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | H. | M. | | An. | Ae. | Az. | | |
| | 1913. | | | | | | | | | | |
| 39 * | July | 12 ... | eP | 10 | 47·4 | ... | ... | ... | ... | .. | Widening of line. |
| | | | F | 11 | 53·6 | ... | ... | ... | ... | ... | |
| 40 | | 28 ... | eP | 7 | 00·3 | ... | ... | ... | .. | .. | |
| | | | iL | 7 | 07·4 | ... | ... | ... | ... | ... | |
| | | | M | 7 | 10·4 | ... | ... | 60 | ... | ... | |
| | | | F | 7 | 42·2 | ... | .. | ... | ... | ... | |
| 41 | Aug. | 1 ... | eP | 17 | 22·1 | ... | ... | .. | ... | ... | |
| | | | iL | 17 | 31·9 | ... | ... | ... | ... | ... | |
| | | | M | 17 | 33·4 | ... | ... | 50 | ... | ... | |
| | | | F | | ? | ... | ... | ... | .. | ... | |
| 42 | | 1 ... | P | | ? | ... | ... | ... | ... | ... | |
| | | | eL | 17 | 53·2 | ... | ... | ... | ... | ... | |
| | | | M | 17 | 59·8 | ... | ... | 110 | . | ... | |
| | | | F | 18 | 54·5 | ... | ... | ... | ... | ... | |
| 43 | | 6—7 ... | eP | 22 | 28·8 | ... | ... | ... | ... | ... | |
| | | | iL | 22 | 47·7 | ... | ... | ... | ... | ... | |
| | | | M | 23 | 46·7 | ... | ... | 410 | ... | ... | |
| | | | F | 1 | 30·0 | ... | ... | ... | ... | ... | |
| 44 | | 7 ... | eP | 14 | 37·8 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 15 | 39·3 | ... | ... | ... | ... | ... | |
| 45 | | 13 ... | eP | 4 | 28·8 | ... | ... | ... | ... | ... | |
| | | | iL | 4 | 40·8 | ... | ... | ... | ... | ... | |
| | | | M | 4 | 48·0 | ... | ... | 580 | ... | | |
| | | | F | 5 | 44·9 | ... | ... | ... | ... | | |
| 46 | Sept. | 3 ... | eP | 22 | 02·8 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 23 | 30·0 | ... | ... | ... | ... | ... | |
| 47 | | 13 ... | eP | 2 | 22·6 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 2 | 56·7 | ... | ... | ... | .. | . | |
| 48 | | 16 ... | eP | 12 | 17·7 | ... | ... | ... | ... | ... | |
| | | | eL | 12 | 19·2 | ... | ... | ... | ... | ... | |
| | | | M | 12 | 23·3 | ... | ... | 90 | ... | ... | |
| | | | F | 12 | 40·3 | ... | ... | ... | ... | ... | |
| 49 | Oct. | 11 ... | eP | 1 | 45·9 | ... | ... | ... | .. | ... | Widening of line. |
| | | | F | 3 | 12·0 | ... | ... | ... | ... | ... | |
| 50 | | 11 ... | eP | 4 | 18·2 | ... | ... | ... | ... | ... | Instrument examined at 3h 54m. |
| | | | eL | 4 | 27·4 | ... | ... | ... | ... | ... | |
| | | | M | 4 | 52·8 | ... | ... | 50 | ... | ... | |
| | | | F | | ? | ... | ... | ... | ... | | |
| 51 | | 11 ... | P | | ? | ... | ... | ... | ... | ... | |
| | | | L | 9 | 29·5 | ... | ... | ... | ... | ... | |
| | | | M | 10 | 03·6 | ... | ... | 50 | | ... | |
| | | | F | 10 | 49·5 | ... | ... | ... | ... | ... | |
| 52 | | 11 ... | eP | 11 | 01·3 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 12 | 21·8 | ... | ... | ... | | ... | |
| 53 | | 14 ... | eP | 7 | 59·7 | ... | ... | ... | ... | ... | |
| | | | iL | 8 | 32·0 | ... | ... | ... | ... | ... | |
| | | | M | 9 | 14·9 | ... | ... | 120 | ... | ... | |
| | | | F | 10 | 51·0 | ... | ... | ... | ... | ... | |
| 54 | Nov. | 6—7 ... | eP | 21 | 36·2 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 0 | 02·0 | ... | ... | ... | ... | ... | |
| 55 | | 14 ... | P | | | ... | | ... | ... | ... | |
| | | | iL | 20 | 56·9 | ... | ... | ... | ... | ... | |
| | | | M | 20 | 59·0 | ... | ... | 180 | .. | ... | |
| | | | F | 21 | 24·4 | ... | ... | ... | ... | ... | |
| 56 | | 15 ... | eP | 6 | 22·1 | ... | ... | .. | ... | ... | Widening of line. |
| | | | F | 6 | 48·4 | ... | ... | ... | ... | ... | |
| 57 | | 19 ... | eP | 3 | 29·2 | ... | ... | ... | ... | . | |
| | | | L | 3 | 40·2 | ... | ... | ... | ... | ... | |
| | | | M | 3 | 52·5 | ... | ... | 200 | ... | ... | |
| | | | $M_2$ | | 55·3 | ... | ... | 200 | ... | ... | |
| | | | F | 4 | 35·6 | ... | ... | ... | ... | ... | |
| 58 | | 23 ... | eP | 22 | 02·8 | ... | ... | .. | ... | ... | Widening of line. |
| | | | F | 22 | 24·4 | ... | ... | ... | ... | ... | |
| 59 | Dec. | 2 ... | iP | 20 | 06·6 | ... | ... | ... | ... | ... | |
| | | | iL | 20 | 07·6 | ... | ... | ... | . | ... | |
| | | | M | 20 | 08·6 | ... | ... | 60 | ... | ... | |
| | | | F | 20 | 18·9 | ... | ... | ... | ... | ... | |
| 60 | | 10 ... | eP | 6 | 33·5 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 7 | 41·9 | ... | ... | ... | ... | ... | |
| 61 | | 21 ... | eP | 15 | 46·5 | ... | ... | ... | | ... | |
| | | | iL | 15 | 48·3 | ... | ... | ... | ... | ... | |
| | | | M | 15 | 58·3 | ... | ... | 300 | ... | ... | |
| | | | F | 17 | 33·7 | ... | ... | ... | ... | ... | |

* Air tremors during high wind July 16—20.

# APPENDIX II.

LATITUDE, 10° 13′ 50″ N.
LONGITUDE, $5^h$ $9^m$ $52^s$ E.

Height of Barometer cistern above mean sea level 7,688 feet.

## MEAN monthly and annual meteorological results at the Kodaikanal Observatory in 1913.

| Month. | Barometer. | | Dry bulb thermometer. | | | | Wet bulb. | | Tension of vapour. | Relative humidity. | Sun max. in *vac.* | Min. on grass. | Wind. | | | Rain. | | Clear sky. | Bright sun-shine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reduced to 32°. | Daily range. | Mean. | Max. | Min. | Range. | Mean. | Min. | By Blanford's tables. | | | | Daily velo-city. | Mean direction. | | Amount. | Days. | | |
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | POINTS. | POINTS. | INCHES. | NO. | CENTS. | HOURS. |
| January ... | 22·857 | 0·064 | 57·0 | 66·5 | 47·4 | 19·1 | 47·6 | 40·1 | 0·262 | 59 | 126·4 | 36·9 | 278 | 6 | E.N.E. | 0·27 | 2 | 53 | 212·3 |
| February ... | ·854 | ·065 | 57·6 | 68·2 | 47·0 | 21·2 | 49·1 | 41·5 | ·283 | 60 | 133·0 | 37·3 | 296 | 8 | E. | 1·07 | 2 | 63 | 227·2 |
| March ... | ·850 | ·064 | 60·8 | 71·0 | 50·5 | 20·5 | 50·0 | 42·8 | ·260 | 50 | 138·3 | 39·8 | 286 | 8 | E. | 5·30 | 5 | 68 | 275·5 |
| April ... | ·830 | ·060 | 62·7 | 71·5 | 54·0 | 17·5 | 54·5 | 48·9 | ·355 | 65 | 141·0 | 45·3 | ... | | ... | 4·18 | 8 | 58 | 240·0 |
| May ... | ·805 | ·065 | 63·0 | 71·4 | 54·6 | 16·8 | 55·9 | 50·5 | ·391 | 71 | 140·0 | 46·8 | | .. | ... | 3·52 | 11 | 46 | 232·2 |
| June ... | ·751 | ·049 | 59·6 | 65·9 | 53·3 | 12·6 | 54·3 | 49·5 | ·375 | 75 | 131·6 | 49·5 | ... | ... | ... | 2·30 | 6 | 34 | 192·1 |
| July ... | ·757 | ·055 | 58·1 | 63·5 | 52·7 | 10·8 | 53·7 | 49·1 | ·377 | 80 | 129·4 | 48·7 | ... | . | ... | 6·08 | 11 | 27 | 162·4 |
| August ... | ·781 | ·055 | 57·8 | 64·2 | 51·4 | 12·8 | 53·0 | 48·1 | ·364 | 78 | 129·6 | 47·3 | 322 | 26 | W.N.W. | 4·94 | 11 | 39 | 192·7 |
| September ... | ·805 | ·066 | 58·3 | 64·8 | 51·8 | 13·0 | 54·1 | 49·0 | ·383 | 80 | 129·5 | 47·4 | 211 | 26 | W.N.W. | 6·57 | 11 | 34 | 158·8 |
| October ... | ·827 | ·070 | 57·3 | 63·1 | 51·5 | 11·6 | 53·5 | 48·9 | ·384 | 84 | 123·3 | 46·7 | 258 | 30 | N.N.W. | 5·57 | 12 | 21 | 134·2 |
| November ... | ·844 | ·068 | 54·9 | 60·3 | 49·4 | 10·9 | 51·5 | 47·3 | ·357 | 85 | 113·6 | 45·6 | 283 | 1 | N by E. | 9·04 | 12 | 29 | 137·5 |
| December ... | ·867 | ·065 | 54·7 | 61·6 | 47·8 | 13·8 | 49·9 | 44·1 | ·322 | 76 | 115·6 | 41·5 | 325 | 5 | N.E. by E. | 7·44 | 13 | 39 | 190·8 |
| Annual | 22·819 | 0·062 | 58·5 | 66·0 | 51·0 | 15·0 | 52·3 | 46·7 | 0·343 | 72 | 129·3 | 44·4 | 282 | 2 | N.N.E. | 56·28 | 104 | 43 | 2355·7 |

## EXTREME monthly meteorological records at the Kodaikanal Observatory in 1913.

| Month. | Barometer. | | | | | Dry bulb thermometer. | | | | Wet bulb. | | Humidity. | | Sun th. in *vacuo.* | | Grass therm. | | Wind. | | | | Rain. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | | Lowest. | | Range. | Highest. | | Lowest. | | Lowest. | | Lowest. | | Highest. | | Lowest. | | Highest. | | Lowest. | | Greatest fall. | |
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY. |
| January ... | 22·942 | 27, 31 | 22·757 | 7 | 0·185 | 73·3 | 4 | 43·6 | 9,28 | **31·3** | 4 | **11** | 4 | 143·3 | 19 | **19·3** | 3 | 412 | 18 | 143 | 10,11 | 0·10 | 19,25 |
| February ... | ·944 | 1 | ·769 | 28 | ·175 | 73·7 | 23,24 | 40·6 | 5 | 32·0 | 5 | 25 | 8 | 146·6 | 24 | 29·0 | 24 | 397 | 13 | 164 | 1 | 0·89 | 15 |
| March ... | ·942 | 29 | ·763 | 14 | ·179 | 75·0 | 26 | 45·7 | 24 | 36·1 | 24 | 13 | 25 | **152·7** | 5 | 27·8 | 24 | 470 | 1 | 190 | 16 | **2·94** | **29** |
| April ... | ·911 | 1 | ·731 | 25 | ·180 | 73·9 | 14 | 51·4 | 10 | 40·0 | 12 | 21 | 12 | 150·2 | 25 | 37·8 | 10 | ... | ... | ... | | 1·19 | 28 |
| May ... | ·901 | 3 | ·679 | 31 | ·222 | **77·4** | **12** | 52·0 | 21 | 44·0 | 12 | 37 | 12 | 151·0 | 27 | 41·9 | 12,20 | ... | ... | ... | .. | 0·66 | 30 |
| June ... | ·858 | 29 | **·587** | **4** | ·271 | 69·5 | 1 | 49·8 | 26 | 43·8 | 20 | 35 | 26 | 144·8 | 1 | 45·0 | 18,20 | ... | | .. | .. | 0·60 | 5 |
| July ... | ·834 | 13 | ·635 | 16 | ·199 | 68·4 | 1 | 49·7 | 6 | 43·4 | 7 | 49 | 19 | 140·3 | 26 | 41·2 | 29 | ... | ... | ... | .. | 1·85 | 3 |
| August ... | ·892 | 26 | ·692 | 14 | ·200 | 69·7 | 9 | 47·0 | 24 | 43·0 | 30 | 52 | 30 | 142·9 | 26 | 42·1 | 10 | 585 | 6 | 124 | 27 | 0·87 | 12 |
| September ... | ·884 | 20 | ·713 | 1 | ·171 | 70·7 | 10 | 48·9 | 10 | 44·9 | 8 | 61 | 14 | 148·9 | 17 | 40·0 | 10 | 453 | 2 | 108 | 13 | 1·32 | 20 |
| October ... | ·924 | 21 | ·713 | 14 | ·211 | 67·7 | 4 | 46·1 | 22 | 40·5 | 25 | 39 | 1 | 142·8 | 8 | 39·0 | 22 | 487 | 25 | 98 | 17 | 1·20 | 6 |
| November ... | ·938 | 21 | ·759 | 9 | ·179 | 68·5 | 17 | 43·0 | 14 | 33·6 | 14 | 35 | 14 | 136·4 | 18 | 31·2 | 14 | 610 | 8 | 120 | 2 | 1·38 | 1 |
| December ... | **23·000** | **30** | ·747 | 13 | ·253 | 69·3 | 26 | **39·4** | **30** | 32·7 | 27 | 18 | 27 | 133·1 | 23 | 24·5 | 26 | 742 | 16 | 150 | 3 | 1·34 | 8 |

# APPENDIX III.

## KODAIKANAL mean hourly wind velocity for the year 1913.

| Month. | Hours. | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| January ... | 12 | 12 | 12 | 11 | 11 | 12 | 12 | 13 | 14 | 15 | 14 | 13 | 13 | 12 | 12 | 10 | 9 | 9 | 9 | 10 | 10 | 11 | 11 | 11 |
| February ... | 12 | 13 | 12 | 13 | 13 | 13 | 14 | 13 | 17 | 17 | 16 | 15 | 14 | 13 | 11 | 11 | 8 | 8 | 8 | 9 | 10 | 11 | 12 | 13 |
| March ... | 12 | 13 | 12 | 13 | 12 | 13 | 13 | 14 | 15 | 18 | 17 | 15 | 13 | 12 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 9 | 10 | 10 |
| April | No record. | | | | | | | | | | | | | | | | | | | | | | | |
| May | | | | | | | | | | | | | | | | | | | | | | | | |
| June | | | | | | | | | | | | | | | | | | | | | | | | |
| July | | | | | | | | | | | | | | | | | | | | | | | | |
| August ... | 15 | 15 | 15 | 15 | 16 | 16 | 14 | 14 | 13 | 14 | 11 | 11 | 11 | 11 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 15 | 15 | 16 |
| September ... | 9 | 10 | 9 | 9 | 10 | 10 | 10 | 9 | 8 | 10 | 9 | 8 | 8 | 8 | 9 | 9 | 8 | 8 | 9 | 8 | 8 | 8 | 9 | 9 |
| October ... | 11 | 12 | 12 | 12 | 12 | 11 | 12 | 12 | 10 | 11 | 10 | 11 | 11 | 10 | 10 | 10 | 9 | 11 | 11 | 12 | 12 | 11 | 12 | 11 |
| November .. | 13 | 13 | 13 | 14 | 13 | 12 | 13 | 12 | 11 | 12 | 11 | 13 | 11 | 11 | 11 | 11 | 10 | 11 | 11 | 13 | 12 | 14 | 13 | 13 |
| December ... | 14 | 14 | 15 | 14 | 14 | 14 | 14 | 14 | 12 | 14 | 15 | 15 | 13 | 13 | 12 | 10 | 11 | 11 | 12 | 13 | 15 | 15 | 15 | 14 |
| Annual ... | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 14 | 13 | 13 | 12 | 11 | 11 | 10 | 9 | 10 | 10 | 11 | 11 | 12 | 12 | 12 |

## APPENDIX IV.

KODAIKANAL mean hourly bright sunshine for the year 1913.

| Month. | Hours. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6–7 | 7–8 | 8–9 | 9–10 | 10–11 | 11–12 | 12–13 | 13–14 | 14–15 | 15–16 | 16–17 | 17–18 |
| January ... ... | 0·05 | 0·61 | 0·68 | 0·71 | 0·78 | 0·81 | 0·78 | 0·73 | 0·67 | 0·58 | 0·39 | 0·05 |
| February ... ... | ·30 | ·82 | ·89 | ·91 | ·86 | ·87 | ·83 | ·75 | ·74 | ·60 | ·42 | ·12 |
| March ... ... | ·41 | ·94 | 1·00 | 1·00 | 1·00 | ·94 | ·79 | ·70 | ·64 | ·65 | ·54 | ·35 |
| April ... ... | ·48 | ·86 | 0·93 | 0·94 | ·89 | ·87 | ·80 | ·65 | ·58 | ·53 | ·29 | ·18 |
| May .. .. | ·48 | ·75 | ·83 | ·90 | ·86 | ·82 | ·75 | ·61 | ·41 | ·52 | ·33 | ·23 |
| June ... | ·14 | ·54 | ·73 | ·77 | ·79 | ·75 | ·58 | ·64 | ·54 | ·48 | ·32 | ·11 |
| July ... .. | ·11 | ·40 | ·54 | ·67 | ·61 | ·61 | ·60 | ·54 | ·44 | ·42 | ·21 | ·09 |
| August ... | ·32 | ·60 | ·76 | ·79 | ·71 | ·63 | ·56 | ·50 | ·47 | ·37 | ·34 | ·16 |
| September ... | ·26 | ·65 | ·72 | ·76 | ·68 | ·54 | ·35 | ·34 | ·26 | ·29 | ·25 | ·18 |
| October ... . | ·19 | ·39 | ·50 | ·59 | ·56 | ·51 | ·47 | ·40 | ·28 | ·22 | ·17 | ·05 |
| November .. ... | ·18 | ·51 | ·66 | ·62 | ·53 | ·56 | ·53 | ·54 | ·49 | ·48 | ·33 | ·06 |
| December ... .. | ·14 | ·55 | ·64 | ·73 | ·70 | ·72 | ·81 | ·73 | ·66 | ·57 | ·45 | ·11 |
| Mean ... | 0·26 | 0·64 | 0·74 | 0·78 | 0·75 | 0·72 | 0·65 | 0·59 | 0·52 | 0·48 | 0·34 | 0·14 |

## APPENDIX V.

NUMBER of days in each month on which the Nilgiris were visible in 1913.

| Month. | Very clear. | Visible. | Just visible. | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January ... ... ... ... | ... | 9 | 4 | 1 | 14 |
| February .. ... ... ... | ... | 3 | 6 | 5 | 14 |
| March ... . ... ... | ... | 1 | ... | ... | 1 |
| April ... ... ... | ... | . . | ... | ... | ... |
| May ... ... ... ... | 4 | ... | 1 | ... | 5 |
| June ... ... ... ... | ... | 2 | 1 | . | 3 |
| July ... ... ... ... | 2 | 2 | 1 | ... | 5 |
| August ... .. ... ... | ... | .. | 2 | ... | 2 |
| September ... ... ... | 6 | 9 | 5 | ... | 20 |
| October ... ... ... ... | 4 | 2 | 2 | ... | 8 |
| November ... ... ... | 1 | 2 | 3 | 3 | 9 |
| December ... ... ... ... | 3 | 5 | 2 | 2 | 12 |
| Total ... | 20 | 35 | 27 | 11 | 93 |

# APPENDIX VI.

MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1913.

| Abnormals of | January. | February. | March. | April. | May. | June. | July. | August. | September | October. | November. | December. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure ... ... .. | + 0·019 | — 0·008 | — 0·036 | — 0·026 | — 0·007 | — 0·029 | — 0·011 | — 0 013 | + 0·003 | — 0·023 | + 0·024 | + 0·024 | — 0 002 |
| Temperature of air ... ... ... .. ... | + 0·4 | + 2·1 | + 1·9 | + 1·4 | + 0·5 | + 2·2 | + 1·1 | + 2·8 | + 1·6 | Same as | + 0 6 | + 0·9 | + 1·3 |
| Do. of evaporation .. ... ... | + 0·2 | + 3·0 | + 1·2 | + 1·6 | + 1·0 | + 1·6 | + 1·4 | + 0·6 | + 2·0 | + 0·6 | + 1·1 | + 2·0 | + 1·3 |
| Percentage of humidity . ... ... ... | Same as | + 4 | — 2 | + 1 | + 2 | — 1 | + 3 | — 8 | + 3 | + 3 | + 2 | + 6 | + 1 |
| Greatest solar heat in *vacuo* . ... ... ... | — 8·0 | — 5·6 | — 2 6 | — 3·9 | — 4·1 | — 7·6 | — 8·0 | — 4·3 | — 1·7 | — 10·0 | — 15·2 | — 12·6 | — 7·0 |
| Maximum in shade ... ... .. ... .. | — 0·4 | + 0·4 | + 2·8 | + 1·3 | + 0·5 | + 1·9 | + 0·3 | + 3·9 | + 1·8 | — 0·4 | — 1·0 | — 0·5 | + 0·8 |
| Minimum in shade ... ... .. ... ... | + 0·3 | + 3·2 | + 1·0 | + 1·7 | — 0·3 | + 2·4 | + 0·6 | + 2·6 | + 1·1 | — 0·6 | + 1·1 | + 1·3 | + 1·2 |
| Do. on grass ... ... ... ... ... | + 1·9 | + 4·9 | + 2·2 | — 2·6 | + 0·8 | + 2·7 | + 1·4 | + 3·1 | + 2·1 | + 0·5 | + 2·0 | + 2·4 | + 2·3 |
| Rainfall in inches ... ... ... ... .. | — 0·75 | — 0·28 | — 0·39 | — 0·60 | + 0·02 | — 1·98 | —0·76 | — 3·84 | — 1·68 | + 17 28 | + 4·78 | + 4·23 | ... |
| Do. since January ... ... ... .. | ... | — 1·03 | — 1·42 | — 2·02 | - 2·00 | — 3·98 | —4·74 | — 8·58 | —10·26 | + 7·02 | + 11·80 | + 16·03 | + 16·03 |
| General direction of wind ... ... ... ... | 2 points N. | Same as | 2 points S. | Same as | 1 point S. | 2 points S. | 2 points S. | 1 point W. | 1 point S. | 5 points N. | 1 point E. | 3 points E. | 1 point E. |
| Daily velocity in miles ... ... ... ... | + 23 | — 2 | — 8 | + 2 | — 19 | — 25 | —18 | + 7 | —10 | — 4 | + 17 | — 26 | — 5 |
| Percentage of cloudy sky ... ... ... ... | — 6 | + 3 | —14 | — 7 | — 12 | — 11 | — 3 | — 2 | —13 | — 2 | + 3 | Same as | — 6 |
| Do. of bright sunshine ... ... ... | — 13·8 | — 5·4 | + 2·6 | + 2·4 | — 0·6 | — 0·2 | — 1·0 | + 3·9 | +11·0 | — 5·7 | — 11·0 | — 6·7 | — 6·5 |

+ means above normal ; — below normal.

## APPENDIX VII.

**Abstract** of the mean meteorological condition of Madras in the year 1913 compared with the average of past years.

| Mean values of | 1913. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure ... ... ... ... ... | 29·862 | 0·002 below. | 29·864 |
| Temperature of air ... ... ... ... ... ... | 82·4 | 1·3 above. | 81·1 |
| Do. of evaporation ... ... ... ... ... | 75·8 | 1·3 „ | 74·5 |
| Percentage of humidity ... ... ... ... ... ... | 73 | 1 „ | 72 |
| Greatest solar heat in *vacuo* ... ... ... ... ... | 132·7 | 7·0 below. | 139·7 |
| Maximum in shade ... ... ... ... ... ... | 91·6 | 0·8 above. | 90·8 |
| Minimum in shade ... ... ... ... ... ... ... | 75·9 | 1·2 „ | 74·7 |
| Do. on grass ... ... ... ... ... ... ... | 74·2 | 2·3 „ | 71·9 |
| Rainfall in inches since January 1st on 88 days ... ... | 65·05 | 16·03 „ | 49·02 |
| General direction of wind ... ... .. ... ... | S.E. by E. | 1 point E. | S.E |
| Daily velocity in miles ... ... ... ... ... ... | 166 | 5 below. | 171 |
| Percentage of cloudy sky ... ... ... ... ... | 43 | 6 „ | 49 |
| Do. of bright sunshine ... ... ... ... ... | 51·9 | 6·5 „ | 58·4 |

**Duration** and quantity of the wind from different points.

| From | Hours | Miles. | From | Hours | Miles. | From | Hours | Miles. | From | Hours | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North ... | 244 | 1,474 | East ... | 259 | 1,399 | South ... | 208 | 1,536 | West ... | 207 | 1,643 |
| N. by E. ... | 407 | 2,501 | E. by S. ... | 289 | 1,777 | S. by W. | 185 | 1,288 | W. by N. | 153 | 1,365 |
| N.N.E. ... | 509 | 3,645 | E.S.E. ... | 298 | 1,758 | S.S.W. ... | 247 | 1,607 | W.N.W.... | 104 | 941 |
| N.E. by N. | 573 | 4,744 | S.E. by E. | 399 | 2,332 | S.W. by S. | 250 | 1,847 | N.W.by W. | 92 | 692 |
| N.E. ... | 314 | 2.132 | S.E. ... | 416 | 2,834 | S.W. ... | 157 | 1,073 | N.W. ... | 61 | 342 |
| N.E. by E. | 270 | 1,803 | S.E. by S. | 819 | 7,037 | S.W. by W. | 183 | 1,311 | N.W. by N. | 38 | 239 |
| E.N.E. ... | 132 | 820 | S.S.E. ... | 548 | 4,634 | W.S.W. ... | 230 | 1,704 | N.N.W.... | 51 | 277 |
| E. by N. | 260 | 1,280 | S. by E. ... | 264 | 2,103 | W. by S. | 270 | 1,961 | N. by W. | 88 | 590 |

There were 135 calm hours during the year. The resultant corresponding to the above numbers is represented by a S.E. by E. wind, blowing with a uniform daily velocity of 39 miles.

# APPENDIX VIII.

MADRAS OBSERVATORY—Number of hours of wind from each point in the year 1913.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January ... | 25 | 174 | 168 | 166 | 80 | 73 | 20 | 31 | 3 | ... | ... | ... | ... | .. | .. | ... | ... | ... | ... | ... | .. | ... | .. | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4 |
| February ... | ... | 4 | ... | 40 | 35 | 10 | 39 | 73 | 109 | 114 | 147 | 47 | 19 | 4 | ... | ... | 2 | .. | 3 | 1 | ... | ... | ... | ... | .. | ... | ... | .. | ... | ... | ... | ... | 25 |
| March ... | ... | ... | ... | ... | .. | 12 | 1 | 36 | 16 | 26 | 7 | 121 | 103 | 207 | 103 | 19 | 12 | 12 | 24 | 25 | 1 | 1 | ... | . | ... | .. | ... | ... | ... | ... | ... | ... | 18 |
| April ... | 1 | 1 | 1 | ... | 1 | ... | ... | 3 | 2 | 12 | 3 | 39 | 63 | 333 | 135 | 35 | 23 | 23 | 19 | 7 | 1 | 2 | ... | .. | .. | .. | ... | ... |  | ... | 2 | 2 | 12 |
| May ... | ... | ... | . | 1 | 5 | 2 | .. | 2 | 1 | 1 | 12 | 21 | 47 | 153 | 110 | 91 | 71 | 43 | 42 | 36 | 24 | 15 | 13 | 16 | 4 | 6 | 3 | 2 | 11 | 2 | 4 | 3 | 3 |
| June ... | 3 | 2 |  | . | ... |  |  | 3 | 5 | 27 | 24 | 56 | 49 | 86 | 63 | 44 | 14 | 19 | 11 | 19 | 14 | 27 | 49 | 60 | 40 | 38 | 20 | 20 | 7 | 6 | 5 | 1 | 8 |
| July ... | ... | 12 | 2 | ... | 2 | 1 | 11 | 9 | 26 | 22 | 12 | 11 | 35 | 28 | 24 | 34 | 21 | 32 | 72 | 55 | 41 | 59 | 63 | 57 | 50 | 32 | 11 | 14 | 2 | 3 | .. | .. | 3 |
| August ... | 3 | 1 | 1 | .. | ... | 1 | 1 | 1 | 5 | 18 | 19 | 36 | 33 | 33 | 39 | 10 | 13 | 25 | 33 | 34 | 36 | 41 | 57 | 62 | 77 | 50 | 51 | 28 | 15 | 9 | 7 | 4 | 1 |
| September... | 4 | 2 | 5 | 27 | 2 | 5 | 1 | 24 | 13 | 24 | 21 | 38 | 49 | 50 | 69 | 23 | 22 | 22 | 33 | 40 | 24 | 22 | 26 | 36 | 16 | 19 | 12 | 17 | 9 | 12 | 22 | 20 | 11 |
| October ... | 51 | 34 | 44 | 85 | 43 | 24 | 6 | 16 | 59 | 28 | 23 | 3 | 8 | 6 | 4 | 8 | 13 | 5 | 10 | 33 | 16 | 16 | 22 | 39 | 20 | 8 | 7 | 11 | 17 | 6 | 11 | 34 | 24 |
| November ... | 129 | 108 | 124 | 164 | 60 | 45 | 12 | 6 | 17 | 3 | 9 | 17 | ... | ... | .. | ... | .. | ... | .. | ... | ... | ... | .. | ... | ... |  | ... | .. | ... | ... | ... | 19 | 7 |
| December ... | 28 | 69 | 164 | 90 | 86 | 97 | 41 | 56 | 3 | 14 | 21 | 10 | 10 | 19 | 1 | ... | 17 | 4 | ... | ... | ... | ... | ... | ... | ... | ... | ... | . | ... | ... | ... | 5 | 19 |
| Annual total | 244 | 407 | 509 | 573 | 314 | 270 | 132 | 260 | 259 | 289 | 298 | 399 | 416 | 819 | 548 | 264 | 208 | 185 | 247 | 250 | 157 | 183 | 230 | 270 | 207 | 153 | 104 | 92 | 61 | 38 | 51 | 88 | 135 |

# APPENDIX IX.

Madras Observatory—Number of miles of wind from each point in the year 1913.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January ... ... | 218 | 946 | 999 | 1467 | 669 | 525 | 209 | 126 | 23 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 5182 |
| February ... ... | ... | 29 | ... | 132 | 120 | 101 | 161 | 411 | 589 | 637 | 716 | 293 | 103 | 30 | ... | ... | 19 | ... | 21 | 10 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3372 |
| March... ... ... | ... | ... | ... | ... | ... | 59 | 3 | 118 | 112 | 161 | 60 | 569 | 500 | 1279 | 789 | 143 | 101 | 108 | 222 | 232 | 7 | 4 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4467 |
| April ... ... ... | 7 | 5 | 4 | ... | 10 | ... | .. | 22 | 9 | 59 | 24 | 242 | 502 | 2659 | 1188 | 318 | 225 | 222 | 179 | 69 | 6 | 9 | ... | ... | ... | ... | ... | ... | ... | ... | 9 | 14 | 5782 |
| May ... ... ... | ... | ... | ... | 5 | 30 | 23 | ... | 21 | 10 | 6 | 111 | 171 | 420 | 1521 | 1198 | 722 | 614 | 325 | 267 | 322 | 203 | 117 | 66 | 107 | 27 | 41 | 16 | 5 | 48 | 7 | 15 | 26 | 6444 |
| June ... ... ... | 23 | 13 | ... | ... | ... | ... | ... | 27 | 42 | 238 | 225 | 323 | 389 | 673 | 477 | 324 | 95 | 106 | 71 | 128 | 96 | 229 | 440 | 562 | 404 | 357 | 243 | 224 | 63 | 41 | 28 | 6 | 5847 |
| July ... ... ... | ... | 28 | 11 | ... | 15 | 12 | 109 | 102 | 206 | 140 | 107 | 114 | 298 | 205 | 196 | 240 | 155 | 195 | 443 | 441 | 280 | 455 | 488 | 440 | 354 | 311 | 97 | 83 | 19 | 23 | ... | ... | 5567 |
| August ... ... | 19 | 5 | 7 | ... | ... | 9 | 9 | 8 | 51 | 150 | 161 | 215 | 264 | 254 | 258 | 79 | 68 | 180 | 168 | 242 | 228 | 266 | 427 | 510 | 689 | 462 | 462 | 207 | 85 | 61 | 45 | 35 | 5624 |
| September ... ... | 26 | 17 | 35 | 121 | 13 | 45 | 4 | 80 | 49 | 158 | 155 | 291 | 284 | 370 | 488 | 200 | 147 | 129 | 180 | 226 | 142 | 120 | 144 | 175 | 93 | 152 | 89 | 107 | 67 | 73 | 99 | 115 | 4394 |
| October ... ... | 164 | 209 | 281 | 515 | 220 | 109 | 44 | 91 | 221 | 144 | 94 | 14 | 23 | 41 | 40 | 29 | 91 | 23 | 56 | 177 | 111 | 111 | 139 | 167 | 76 | 42 | 34 | 66 | 60 | 34 | 81 | 174 | 3681 |
| November ... ... | 835 | 713 | 1067 | 1630 | 416 | 319 | 73 | 56 | 60 | 15 | 28 | 66 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 181 | 5459 |
| December ... ... | 182 | 536 | 1241 | 874 | 639 | 601 | 208 | 218 | 27 | 69 | 77 | 34 | 51 | 5 | ... | 48 | 21 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 39 | 4870 |
| Annual ... ... | 1474 | 2501 | 3645 | 4744 | 2132 | 1803 | 820 | 1280 | 1399 | 1777 | 1758 | 2332 | 2834 | 7037 | 4634 | 2103 | 1536 | 1288 | 1607 | 1847 | 1073 | 1311 | 1704 | 1961 | 1643 | 1365 | 941 | 692 | 342 | 239 | 277 | 590 | 60689 |

# APPENDIX X.

MADRAS OBSERVATORY—Number of inches of rain from each point in the year 1913.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January ... | ... | ... | 0·14 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| February ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| March ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| April ... | ... | ... | ... | ... | 0·02 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| May ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·19 | ... | ... | ... | 0·12 | ... | 0·45 | 0·15 | 0·44 | ... | 0·05 | ... | ... | ... | ... | 0·30 | ... | ... | ... | ... | ... | 0·44 | ... |
| June ... | 0·03 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·01 | 0·01 | ... | 0·07 | 0·01 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| July ... | ... | ... | ... | ... | ... | ... | 0·05 | ... | 0·03 | ... | ... | ... | 0·01 | 0·02 | ... | 0·63 | 0·47 | ... | ... | ... | 0·30 | 0·89 | 0·29 | ... | 0·37 | 0·05 | ... | ... | ... | ... | ... | ... | ... |
| August ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·02 | 0·09 | ... | ... | 0·01 | 0·01 | 0·20 | ... | 0·18 | ... | 0·15 | 0·05 | 0·01 | ... | ... | ... | ... | ... | ... | ... |
| September. | ... | 0·08 | ... | 0·16 | ... | ... | ... | 0·03 | ... | ... | ... | 0·22 | ... | ... | ... | 0·02 | ... | 0·11 | 0·01 | 0·03 | 0·13 | 0·33 | 0·07 | 0·07 | 0·47 | 0·91 | 0·01 | 0·06 | 0·22 | ... | 0·02 | 0·04 | 0·02 |
| October ... | 2·38 | 4·31 | 1·30 | 1·15 | 0·52 | 0·41 | 0·33 | 1·93 | 0·69 | ... | ... | 0·02 | 0·03 | ... | ... | 0·96 | 0·79 | 0·40 | 0·12 | 0·04 | 0·02 | 0·67 | ... | 1·99 | 0·22 | 0·26 | 0·02 | 0·85 | 1·49 | 0·90 | 0·88 | 5·55 | 0·05 |
| November. | 0·21 | 5·87 | 5·01 | 3·70 | 1·79 | 1·00 | 0·22 | 0·18 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·01 | ... |
| December ... | 0·05 | 0·49 | 2·16 | 0·34 | 1·41 | 2·18 | 0·53 | 0·45 | 0·17 | 0·29 | ... | 1·04 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·40 | ... |
| Annual ... | 2·67 | 10·75 | 8·61 | 5·35 | 3·74 | 3·59 | 1·13 | 2·59 | 0·89 | 0·29 | 0·19 | 1·29 | 0·05 | 0·04 | 0·28 | 1·62 | 1·71 | 0·67 | 0·58 | 0·27 | 0·50 | 2·07 | 0·36 | 2·21 | 1·11 | 1·53 | 0·03 | 0·91 | 1·71 | 0·90 | 0·90 | 6·44 | 0·07 |

# APPENDIX XI.

MADRAS OBSERVATORY—Wind, cloud and bright sunshine, 1913.

| Month. | Wind resultant. | | Clouds (0—10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H. | 16 H. | 20 H. | Mean. | Average per day. | Greatest number of hours in a day. |
| | MILES. | POINTS. | | | | | | HOURS. | HOURS. |
| January ... ... | 159 | N.E. by N. | 2·8 | 3·9 | 3·4 | 2·0 | 3·1 | 6·2 | 8·6 |
| February ... ... | 107 | E. by S. | 2·9 | 3·8 | 2·3 | 1·8 | 2·7 | 8·4 | 10·3 |
| March ... ... | 127 | S.E. by S. | 1·0 | 1·6 | 1·1 | 0·2 | 1·0 | 9·2 | 10·4 |
| April ... ... | 179 | S.S.E. | 3·3 | 2·7 | 1·7 | 0·7 | 2·1 | 8·9 | 10·4 |
| May ... ... | 168 | S. by E. | 2·4 | 2·5 | 2·5 | 2·6 | 2·6 | 7·6 | 9·1 |
| June ... ... | 83 | S.S.W. | 4·8 | 4·6 | 6·0 | 5·8 | 5·3 | 5·1 | 7·7 |
| July ... ... | 94 | S.W. by S. | 6·7 | 6·4 | 7·4 | 6·7 | 6·8 | 3·9 | 8·3 |
| August ... ... | 72 | S.W. by W. | 6·4 | 5·6 | 6·7 | 7·0 | 6·5 | 5·3 | 10·0 |
| September ... | 55 | S by E. | 4·7 | 4·7 | 5·4 | 4·8 | 4·9 | 6·4 | 10·7 |
| October ... ... | 34 | N.N.E. | 5·5 | 5·8 | 6·3 | 5·2 | 5·7 | 5·2 | 10·5 |
| November ... | 168 | N.N.E. | 6·2 | 6·7 | 6·7 | 5·1 | 6·2 | 4·2 | 9·5 |
| December ... | 138 | N.E. by N. | 5·3 | 5·8 | 5·3 | 4·3 | 5·2 | 5·2 | 8·7 |
| Annual ... | 39 | S.E. by E. | 4·3 | 4·5 | 4·6 | 3·9 | 4·3 | 6·3 | ... |

# APPENDIX XII.

## Mean Monthly and Annual Meteorological Results at the Madras Observatory in 1913.

| Months. | Barometer. Reduced to 32°. | Barometer. Daily range. | Dry bulb thermometer. Mean. | Dry bulb thermometer. Max. | Dry bulb thermometer. Min. | Dry bulb thermometer. Range. | Wet bulb. Mean. | Wet bulb. Min. | Tension of vapour. By Blandford's tables. | Relative humidity. By Blandford's tables. | Sun Max. in *vac.* | Min. on grass. | Wind Daily velocity. | Wind | Wind Mean direction. | Rain. Amount. | Rain. Days. | Clear sky. | Bright sun shine |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | MILES. | PTS. | | INCHES. | NO. | CENTS. | HOURS. |
| January ... | 30·016 | 0·114 | 75·5 | 84·2 | 67 8 | 16·4 | 69·4 | 66·2 | 0·638 | 73 | 130·4 | 65·0 | 167 | 3 | N.E. by N. | 0·14 | 1 | 69 | 191·9 |
| February ... | 29·956 | ·124 | 78·8 | 87·0 | 71·2 | 15·8 | 73·8 | 70·8 | ·767 | 77 | 134·1 | 68·7 | 120 | 8 | East. | ... | ... | 73 | 234·7 |
| March ... | ·869 | ·139 | 81·9 | 92·0 | 73·1 | 18·9 | 75·1 | 71·5 | ·781 | 72 | 137·9 | 70·8 | 144 | 12 | S E. | ... | ... | 90 | 284·9 |
| April ... | ·800 | ·134 | 85·4 | 94·2 | 78·9 | 15·3 | 79·2 | 76·8 | ·909 | 75 | 137·8 | 77·3 | 193 | 13 | S.E. by S. | 0·02 | 1 | 79 | 267·5 |
| May ... | ·727 | ·133 | 87·2 | 98·3 | 80·5 | 17·8 | 79·3 | 76·2 | ·891 | 69 | 138·9 | 79·7 | 208 | 16 | South | 2·14 | 6 | 74 | 235·5 |
| June ... | ·674 | 122 | 88·6 | 100·1 | 82·7 | 17·4 | 78·2 | 75·1 | ·824 | 61 | 132·9 | 81·3 | 195 | 17 | S. by W. | 0·13 | 7 | 47 | 152·1 |
| July ... | ·710 | ·121 | 85·6 | 95·9 | 79·1 | 16·8 | 77·3 | 74 2 | ·876 | 68 | 130·7 | 78 0 | 180 | 18 | S.S.W. | 3·11 | 11 | 32 | 119·8 |
| August ... | ·737 | ·122 | 86·5 | 97·6 | 79·9 | 17·7 | 76·6 | 73·9 | ·775 | 62 | 135·7 | 78·5 | 181 | 20 | S.W. | 0·72 | 9 | 35 | 164·1 |
| September. | ·781 | ·129 | 84·6 | 95·0 | 78·2 | 16·8 | 78·3 | 75·0 | ·882 | 75 | 139·6 | 77·1 | 146 | 17 | S. by W. | 3·01 | 11 | 51 | 190·5 |
| October ... | ·865 | ·116 | 80·6 | 88·5 | 74·6 | 13·9 | 76·2 | 73·3 | ·846 | 81 | 129·1 | 73·3 | 119 | 4 | N.E. | 28·28 | 18 | 43 | 162·1 |
| November. | ·948 | ·106 | 78·1 | 84·0 | 73·4 | 10·6 | 74·0 | 71·7 | ·784 | 81 | 122·2 | 71·5 | 182 | 3 | N.E. by N. | 17·99 | 12 | 38 | 126·4 |
| December ... | 30·005 | ·107 | 76·4 | 83·1 | 71·1 | 12·0 | 72·6 | 69·7 | ·750 | 83 | 123·2 | 68·8 | 157 | 5 | N.E. by E. | 9·51 | 12 | 48 | 162·0 |
| Annual ... | 29·841 | 0·122 | 82·4 | 91·6 | 75·9 | 15·7 | 75·8 | 72·9 | ·810 | 73 | 132·7 | 74·2 | 166 | 11 | S.E. by E. | 65·05 | 88 | 57 | 2,291·5 |

## Extreme Monthly Meteorological Records at the Madras Observatory in 1913.

| Months. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry bulb thermometer. Highest | | Dry bulb thermometer. Lowest | | Wet bulb. Lowest. | | Humidity. Lowest. | | Sun Th. in *vacuo.* Highest. | | Grass therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY | ° | DAY. | CENTS. | DAY | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY. |
| January ... | 30·166 | 27 | 29·890 | 7 | 0·276 | 86·5 | 24, 30 | **63·1** | **14** | **62 7** | **14, 23** | 48 | 16 | 136·4 | 30 | **59·4** | **14** | 244 | 16 | 95 | 22 | 0·14 | 31 |
| February ... | ·127 | 2 | ·811 | 23 | ·316 | 89·3 | 24 | 64·6 | 10 | 64·6 | 10 | 56 | 4 | 138 9 | 20 | 61·9 | 10 | 185 | 2 | 77 | 7 | ... | .. |
| March ... | ·029 | 2 | ·726 | 17 | ·303 | 97·4 | 21 | 69 2 | 26 | 66·8 | 21 | **27** | **13** | 141 5 | 12 | 65·3 | 26 | 232 | 31 | 92 | 24 | ... | ... |
| April ... | 29·917 | 1 | ·648 | 25 | ·269 | 99·1 | 7 | 73·5 | 12 | 71·2 | 14 | 48 | 9 | 145·4 | 15 | 71·0 | 12 | 249 | 4 | 113 | 14 | 0·02 | 15 |
| May ... | ·864 | 17 | ·577 | 30 | ·287 | **107·7** | **12** | 71·9 | 14 | 69·4 | 14 | 37 | 13 | 146·5 | 14 | 73·1 | 19 | 275 | 10 | 116 | 28 | 0·86 | 18 |
| June ... | ·868 | 29 | **·499** | **6** | ·369 | 105·3 | 20 | 78 9 | 4 | 70·5 | 25 | 31 | 12 | 139 6 | 1 | 78·7 | 11 | 259 | 12 | 85 | 3 | 0·04 | 23 |
| July ... | ·836 | 3 | ·502 | 16, 17 | ·334 | 103·0 | 29 | 70·8 | 4 | 70·8 | 4 | 33 | 23 | 145·1 | 20 | 70·7 | 4 | 259 | 17 | 94 | 11 | 1·75 | 4 |
| August ... | ·898 | 26 | ·588 | 13 | ·310 | 102·4 | 3 | 75·5 | 20 | 70·2 | 24 | 30 | 24 | 145 7 | 2, 3 | 74·0 | 20 | 249 | 24 | 101 | 18 | 0·21 | 13 |
| September. | ·900 | 20 | 601 | 1 | ·299 | 102·1 | 1 | 73·0 | 25 | 72 3 | 25 | 39 | 16 | **148·6** | **10** | 72·0 | 25 | 220 | 18 | 56 | 28 | 1·08 | 6 |
| October ... | 30·050 | 25 | ·618 | 14 | **·432** | 95·1 | 16 | 69·1 | 31 | 68·8 | 31 | 42 | 17 | 142·4 | 17 | 67·1 | 20 | 239 | 26 | 71 | 8, 19 | 5·97 | 31 |
| November ... | ·085 | 21 | ·800 | 9 | ·285 | 87·6 | 21 | 67·3 | 15 | 64·1 | 14 | 60 | 16 | 137·4 | 19 | 63·4 | 15 | **367** | **9** | 78 | 18 | **8·19** | **10** |
| December ... | **257** | **30** | ·837 | 13 | ·420 | 85·6 | 9 | 66·1 | 25 | 65 7 | 25 | 58 | 31 | 133 3 | 9 | 63·3 | 25 | 346 | 16 | **51** | **24** | 3·50 | |

# ANNUAL REPORT

OF THE

# DIRECTOR

# KODAIKANAL AND MADRAS

# OBSERVATORIES

## FOR 1914.

MADRAS:
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1915.

# KODAIKANAL AND MADRAS OBSERVATORIES.

## REPORT FOR THE YEAR 1914.

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### I.—Kodaikanal Observatory.



### II.—Madras Observatory.

# KODAIKANAL AND MADRAS OBSERVATORIES.

## I.—REPORT OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1914.

*Staff.*—The staff of the observatory on December 31, 1914, was as follows:—

| | |
|---|---|
| Director ... ... ... ... ... | J. Evershed. |
| Assistant Director ... ... ... ... | T. Royds, D.Sc. (on combined privilege and special leave). S. Sitarama Ayyar, acting. |
| First Assistant (Acting Assistant Director). | S. Sitarama Ayyar, B.A. |
| Second Assistant (Acting First Assistant). | G. Nagaraja Ayyar. |
| Third Assistant (Acting Second Assistant). | A. A. Narayana Ayyar, B.A. |
| Fourth Assistant ... ... ... ... | S. Balasundaram Ayyar. |
| Writer ... ... ... ... ... | L. N. Krishnaswami Ayyar. |
| Photographic Assistant ... ... ... | R. Krishna Ayyar. |

The Director was away on deputation to New Zealand during January and February, Dr. Royds officiating until his return on March 6.

Early in the year the sanction of Government was obtained for an expedition to Kashmir to test the suitability of the climate for solar research, and on April 21 the Director again left Kodaikanal to take up this work. The very remarkable conditions which had been observed during a holiday tour in Kashmir in August and October 1913 were found to hold also in the months of May, June and July 1914. The definition of the sun was found to be almost invariably good not only on every day that observations were made but also during all hours of the day, and, contrary to all previous experience, the definition was observed to improve during the morning hours reaching the best quality shortly after midday. The detailed report of this expedition in which valuable assistance was given by Mrs. Evershed has been published as Bulletin No. XLII.

The Assistant Director was granted combined leave for six months from November 30, 1914. The Writer was on privilege leave for three months from July 10 and the Second Assistant for one month and eight days from November 16. The Fourth Assistant returned from furlough on August 1, 1914.

The subordinate staff consists of a book-binder, an assistant book-binder, a mechanic, five peons, a boy peon for the dark room and two lascars.

2. *Distribution of work.*—The Director and the Assistant Director have charge of the two spectroheliographs and the large grating spectrograph. The First, Second and Third Assistants are in charge of the work with the Cooke equatorial (spectroscopic), the Lerebour and Secretan equatorial (Visual and photographic), and the transit instrument. They have also to do the astronomical computing, the preparation of the observations for the press and the measurement of spectrum plates. The Third Assistant has charge of the seismometer and clock comparisons. The meteorological work is done by the Fourth Assistant and the Writer. The Fourth Assistant also has assisted Mr. C. Michie Smith, C.I.E., retired Director of the Observatory, in the preparation of a memoir on the meteorology of

Periyakulam and Kodaikanal. The Writer is responsible for the accounts, correspondence, and all office records. The Photographic Assistant has charge of most of the photographic developing, printing, etc.

3. *Buildings and grounds.*—The buildings, grounds, and fire lines have been kept in good order.

The roof of the spectroheliograph building has given much trouble during wet weather from leakage, and part of the roof of the main building also is in a very bad condition. Reconstruction with impervious roofing material is urgently required.

4. *Instruments.*—The following are the principal instruments belonging to the observatory, or in use, at the present time :—

Six-inch Cooke equatorial.

Six-inch Lerebour and Secretan equatorial remounted by Grubb, with a five-inch Grubb portrait lens attached. The Lerebour and Secretan object glass has been replaced by a Cooke photo-visual lens of the same aperture and the instrument has been adapted for direct solar photography in addition to visual work.

Spectrograph I.—This with the 11-inch polar siderostat has been dismounted and a new spectrograph fed by the 12-inch Foucault siderostat from Poona is under construction.

Spectrograph II—consisting of a collimator of 7 feet focus and camera of 14 feet focus placed at an angle of 60° with the former. Plane gratings of 3¼ inches or 5 inches ruled surface are used, and the slit is provided with various devices for the direct comparison of spectra from different sources, and for rotating the solar image.

Spectroheliograph—with 18-inch siderostat and 12-inch Cooke photo-visual lens of 20 feet focus, by the Cambridge Scientific Instrument Company.

An auxiliary spectroheliograph attached to the above, made in the observatory workshop.

Six-inch transit instrument and barrel chronograph, formerly the property of the Survey of India.

Theodolite, 6-inch—Cooke.

Sextant.

Evershed spectroscope with three prisms, for prominence and sunspot work, by Hilger.

Mean time clock, Kullburg 6326.

Do. Shelton.

Mean time chronometer, Kullberg 6299.

Sidereal chronometer, Kullberg 6134.

Tape chronograph, Fuess.

Two micrometers for measuring spectrum photographs, Hilger.

Hartmann Photometer.

Dividing engine, Cambridge Scientific Instrument Company, Limited.

Milne horizontal pendulum seismograph.

Induction coil with necessary adjuncts.

Small polar siderostat.

Universal instrument.

Complete set of meteorological instruments, including a Richard thermograph and barograph and a nephoscope.

A high class screw cutting turning lathe by Messrs. Cooke & Sons.

Angström Pyrheliometer.

An 18-inch concave mirror by Henry of Paris belonging to the Director is mounted in the spectroheliograph room for general spectrum work.

The instruments received from the Takhtasinghji Observatory at Poona include the following :—

Twenty-inch reflecting telescope, by Common.

Six-inch Cooke photo-visual telescope with equatorial mounting.

Two prisms of 6 inches aperture for use with the above.

Twelve-inch Cooke siderostat.

Eight-inch horizontal telescope.

Large grating spectroscope by Hilger.

An ultra-violet spectrograph by Grubb.

Sidereal clock, Cooke.

Mean time chronometer, Frodsham No. 3476.

One micrometer for measuring spectrum photographs, Hilger.

The following instruments were received during the year 1914 :—

(1) Positive on negative spectrum comparator. Constructed by A. Hilger, Limited, from designs by the Director.

(2) Diffraction grating ruled by Anderson with ruled surface $9{\cdot}7 \times 12{\cdot}8$ cm. and total number of lines 75,085.

## OBSERVATIONS.

### (*a*) Solar Physics:

5. The following table gives the number of observations made during each month of the year :—

| — | January. | February. | March | April. | May. | June | July. | August. | September. | October. | November. | December. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 31 | 28 | 31 | 30 | 31 | 29 | 25 | 29 | 30 | 28 | 26 | 25 | 343 |
| B | .. | ... | ... | 9 | ... | 2 | .. | 5 | 1 | ... | 1 | 1 | 19 |
| C | 28 | 28 | 28 | 30 | 25 | 24 | 11 | 22 | 26 | 11 | 24 | 21 | 278 |
| D | 30 | 28 | 31 | 30 | 30 | 29 | 23 | 29 | 30 | 26 | 26 | 24 | 336 |
| E | 31 | 28 | 31 | 30 | 31 | 28 | 20 | 28 | 30 | 23 | 22 | 22 | 329 |

A = disc examined. B = spot spectrum observed. C = prominences observed.
D = photoheliograms taken. E = spectroheliograms taken.

A comparison of this table with those in previous reports shows that about the normal number of routine observations were made and photographs taken. The prominence observations were, however, rather below the average owing to the unusually wet and cloudy period from August to the middle of December.

6. *Photoheliograph.*—Photographs of the sun were obtained on 336 days. A large proportion of the plates are of poor quality owing to unsteadiness of seeing. The 6-inch photovisual telescope and enlarging camera was used throughout and gives excellent definition on the rare occasions when the seeing is good. Eight solar negatives were sent to the Greenwich observatory to complete their series in the period July 1913 to August 1914.

7. *Spectroheliograph.*—Monochromatic photographs of the sun's disc in "K" light were taken on 329 days and prominence plates on 287 days. The autocollimating spectroheliograph was not in use for practically the whole year as the large Michelson grating was required for other work. After installing the new Anderson grating in the spectrograph the Michelson grating was provided with a new mounting and replaced in the spectroheliograph in December. The series of H$\alpha$ spectroheliograms will be continued during 1915.

A new instrument has been constructed in the observatory workshop for the accurate measurement of position angles, heights, and areas of the prominences shown on the spectroheliograms and this was brought into use on October 1st. From this date detailed observation at the telescope of the position angles and heights of the prominences was discontinued as all the required data can be much better determined from the photographs.

Duplicates of the disc photographs in "K" light have been sent to the Cambridge Observatory for measurement.

8. *Grating Spectrograph.*—With this instrument Dr. Royds has continued his researches on the displacements of unsymmetrical lines in the electric arc, and he has succeeded in explaining the anomalous shifts of many of the solar lines as due to density conditions in the arc which are not present in the sun. Although the discovery of this density effect in the arc has complicated the whole subject of the shifts of the arc lines under pressure, and the comparison of arc and solar wave lengths, it leads to a distinct gain in our knowledge of solar conditions not only by explaining the apparently anomalous shifts of some of the solar lines when compared with the arc but also by indicating the extreme tenuity of the solar gases, the combined partial pressures of which appear from independent considerations to be less than one atmosphere.

In Bulletin No. XXXIX the displacements of the spectrum lines at the sun's limb are discussed and the reasons given for the conclusion that the line shift is

not due to a pressure difference between the effective regions of absorption at the limb and at the centre of the disc. In continuation of this research the displacements are now being measured not only at the limb but at numerous points between the limb and centre. With a small solar image on the slit plate spectra 28 mm. in width are obtained representing sections of the entire disc from limb to limb. Many of these plates have been measured and the results so far promise very interesting results.

An important addition to the equipment of the observatory is the new grating of 75,085 lines, ruled by Prof. Anderson on Rowland's Engine. This was received in September and no time was lost in mounting it in the large spectrograph. This grating is the most perfect the observatory possesses and it is now used in all researches where high resolving power is required.

9. *6-inch Cooke Equatorial and Spectroscope.*—This has been employed exclusively for spectrum observations, attention being concentrated on phenomena which cannot readily be photographed, such as metallic prominences, temporary eruptions, and displacements of the hydrogen lines both on the sun's disc and at the limb. The position angles of a few definitely marked prominences are also determined for the purpose of checking the correctness of the angles measured on the photographs; these depend on a fundamental angle computed from the hour angle of the sun at the time a photograph is taken, and errors which would otherwise pass unnoticed may arise in the computation or in the entry of the time.

A large increase in the number of metallic prominences and disturbances showing motion in the line of sight has taken place during 1914 as compared with the previous year.

*Summary of Sunspot and Prominence Observations.*

10. *Sunspots.*—The following table shows the monthly numbers of new groups observed, the mean daily numbers of spots visible and the distribution between the northern and southern hemispheres :—

| — | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups ... ... | 1 | 2 | 6 | 7 | 7 | 4 | 5 | 5 | 4 | 5 | 11 | 14 | 71 |
| Daily number ... ... | 0·3 | 0 2 | 0·4 | 1·2 | 0·6 | 0·8 | 0·5 | 0·6 | 1·3 | 0·6 | 1·7 | 2·5 | 0·9 |
| North ... .. ... | ... | ... | 3 | 3 | 4 | 1 | ... | 2 | 2 | 3 | 4 | 6 | 28 |
| South . ... | 1 | 2 | 3 | 4 | 3 | 3 | 5 | 3 | 2 | 2 | 7 | 8 | 43 |
| Equator ... ... | ... | ... | ... | | ... | . | .. | ... | ... | ... | ... | ... | ... |

The increase of activity compared with the year 1913 is very marked and indicates that the actual minimum of spot activity occurred during 1913.

The steady fall of activity during the years 1910 to 1913 and the sudden rise in 1914 is shown in the table below :—

| — | 1910. | 1911. | 1912. | 1913. | 1914. |
|---|---|---|---|---|---|
| Number of new groups ... ... | 152 | 56 | 22 | 16 | 71 |
| Mean daily numbers ... ... | 1·8 | 0·7 | 0·3 | 0·2 | 0·9 |
| Number of days on which no spot was seen. | 56 | 158 | 240 | 288 | 153 |

Throughout these years there was a marked preponderance of southern over northern spots ; and it may be noted that the minimum activity for the northern hemisphere occurred as early as the year 1912 in which year no northern spots were recorded during the period January to November inclusive with only two in

December. In the southern hemisphere a similar period of complete quiescence occurred during 1913 in the months May to October inclusive. The first appearance of the new cycle of spots in high latitudes occurred in December 1912 after the close of the northern quiescent period and these spots were in the northern hemisphere. With one insignificant exception the southern high latitude spots first appeared in November 1913 immediately following the southern quiescent period.

11. *Prominences.*—The observations indicate a minimum of prominence activity in the year 1913 a notable increase both in numbers and areas having taken place during 1914.

If the two hemispheres of the sun are considered separately the mean areas for the northern hemisphere have their smallest values during the years 1912 and 1913 and remain sensibly constant during those years. In the south there is a steady diminution of prominence area during 1911 and 1912 reaching a minimum value in the second half of 1913.

The mean areas obtained from the photographic and visual records for the years 1913 and 1914 are as follows :—

*Mean daily Profile areas of Prominences in square minutes of arc.*

| — | 1913. | 1914. |
|---|---|---|
| North ... ... ... | 1·08 | 1·50 |
| South ... ... .. | 1·11 | 1·60 |
| Total ... | 2·19 | 3·10 |

It is of interest to note that the time of minimum prominence area for each hemisphere of the sun coincides approximately with the sunspot minimum for the same hemisphere. The great majority of prominences are however not directly associated with sunspots, the zones of greatest activity being in higher latitudes than the spot zones; and the prominences found in the spot latitudes usually occur in the areas between the spot disturbances.

The class of prominence directly connected with spots is distinct and forms a very small proportion of the whole; these prominences naturally follow the sunspot numbers very closely.

Metallic prominences have been more frequently observed during 1914 than during the previous year, altogether seventeen were recorded as against five only in 1913. The increased activity of the sun during 1914 is also shown by the large number of prominences recorded showing displaced lines due to violent movement, both at the limb and near to spot disturbances on the disc. The greatest displacement observed was 5 A towards red in the hydrogen line $\alpha$ corresponding to a velocity of about 230 kilometers per second away from the observer. This was observed on August 26 in a prominence situated at latitude—82° east.

12. *Solar Radiation.*—Observations with the Angstrom Pyrheliometer were obtained from 9th February to 1st May. Later in the year the meteorological conditions were unfavourable for this work.

### (*b*) Other Observations.

13. *Time.*—The error of the standard clock is usually determined by reference to the 16-hour signal from the Madras Observatory. This is rendered possible by the courtesy of the Telegraph Department which permits the Madras wire to be joined through to this observatory. The signal is received with accuracy on most days and all failures are at once reported to the officer in charge of the Trichinopoly division. Independent time determinations have been made with the transit instrument using the Sidereal chronometer K. 6134.

14. *Meteorology.*—Eye observations are made at $8^h$, $10^h$, and $16^h$ local mean time as in former years. The Richard thermograph (wet and dry bulb) and

barograph, the Beckley anemograph and the sunshine recorder also continue in use. The hourly readings from the barograms, thermograms, and sunshine records are now tabulated at the Calcutta Meteorological Office and the anemograms at the Madras Observatory which also prepares the $8^h$ register from readings taken here. The preparation of the $10^h$ and $16^h$ registers is done in the Calcutta Meteorological Office. The wind velocity is obtained as usual from the Robinson anemometer and a wind vane.

Cloud observations with the nephoscope have been made three times a day since March 1, 1914.

*Pressure.*—Except in July and November when there was a defect of 0·018 inch and 0·004 inch respectively the mean monthly pressure was higher than the normal throughout the year; the greatest excess was 0·044 inch in January and October. On the other hand the mean daily range was smaller than the normal practically throughout the year, the only exception being the slight excess of 0·001 inch in September.

*Temperature.*—There was a defect of 1°·6 in the mean maximum for July, but otherwise the temperature was higher than the normal throughout the year whether judged by the mean dry bulb or the mean wet bulb thermometer readings. Excepting July the mean monthly dry bulb maxima were all above normal whilst the mean monthly minima did not show any striking deviations except in December when there was an excess of 2°·0. The mean daily range was consequently higher on the whole than usual.

*Humidity.*—The relative humidity was not very different from the normal the only noticeable deviations being a defect of 14 cents in January and 13 in February.

*Rainfall.*—The rainfall in the year was very abnormally high, the excess being 20·11 inches or 34 per cent. over the normal. The increase in the number of rainy days was only 6 per cent. The rainiest months were October with 15·89 inches, September had 13·60 inches, December 11·78 and May 11·27 inches. The distribution was rather uneven since there was an actual defect of 8·16 inches in the six months—January, February, April, June, July and August. The later monsoon months far more than made up for the defect in the earlier part of the south-west monsoon.

*Wind.*—The wind velocity was in defect by 6 per cent. It was in defect in every month except July, August and December. The highest velocity was 735 miles on the 9th July. The most noticeable deviations in direction were in January, February, and October when they were east, east and east-north-east, whereas normally the directions in those months are north-east, north by east and north by west.

There is some doubt as to whether the anemograph was recording correctly on some days during the months of May and September as the velocity on those days is not consistent with the readings of the Robinson anemometer.

*Transparency of the atmosphere.*—The transparency of the lower atmosphere as judged by the visibility of the Nilgiris, about 100 miles distant, was practically the same as in 1913.

*Cloud and Sunshine.*—The mean clear sky was 38 per cent. which was 6 less than the normal, but the percentage of excess of cloud was less than the percentage of excess of rain. The amount of bright sunshine shows curiously enough an excess of 14 per cent over the normal.

15. *Seismology.*—The milne horizontal pendulum recorded sixty earthquakes against sixty-one in 1913.

16. *Library.*—One hundred and sixty volumes were bound during the year.

17. *Publications.*—Eleven Bulletins, Nos. XXXIV to XLIV were published during the year. Their titles are as follows :—

No. XXXIV.—A comparison of the periodicities in prominences and sunspots, by T. Royds, D.Sc.

No. XXXV.—The apparent effect of planets on the distribution of prominences, by T. Royds, D.Sc., and S. Sitarama Ayyar, B.A.

No. XXXVI.—A new interpretation of the general displacement of the lines of the solar spectrum towards the red, by J. Evershed.

No. XXXVII.—Summary of prominence observations for the second half of the year 1913, by J. Evershed.

No. XXXVIII.—A preliminary note on the displacement to the violet of some lines in the solar spectrum, by T. Royds, D.Sc.

No. XXXIX.—On the displacements of the spectrum lines at the sun's limb, by J. Evershed and T. Royds, D.Sc.

No. XL.—An investigation of the displacement of unsymmetrical lines under different conditions of the electric arc, by T. Royds, D.Sc.

No. XLI.—Summary of prominence observations for the first half of the year 1914, by J. Evershed.

No. XLII.—Report on the conditions for astronomical work in Kashmir, by J. Evershed.

No. XLIII.—The different character of spectrum lines belonging to the same series, by T. Royds, D.Sc.

No. XLIV.—On the displacement at the sun's limb of lines sensitive to pressure and density, by A. A. Narayana Ayyar, B.A.

The following contribution was made in addition to the above :—

The displacement of the lines of the solar spectrum towards the red, by J. Evershed, "The Observatory" March 1914.

No. XLIII had not been distributed at the close of the year.

18. *General.*—The Director-General of Observatories inspected the Kodaikanal Observatory in February.

Professor H. H. Turner, Director of the Oxford University Observatory, paid a visit to the observatory in September on his return from the British Association meeting in Australia.

The staff of the observatory worked well during the year not only in the routine work but also in connection with the measurement and reduction of the spectrum plates required for special researches.

THE OBSERVATORY, KODAIKANAL,
*17th February 1915.*

J. EVERSHED,
*Director, Kodaikanal and Madras Observatories.*

# II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1914.

*Staff.*—The staff at the Observatory on December 31, 1914, was as follows :—

| | |
|---|---|
| Deputy Director .. ... ... ... | R. Ll. Jones. |
| Computer ... ... ... ... ... | S. Solomon Pillai. |
| First Assistant ... ... ... ... ... | C. Chengalvaraya Mudaliyar. |
| Second Assistant ... ... ... ... | E. Ramanujam Pillai. |

Mr. S. Solomon Pillai was absent on privilege leave for two months from 10th March 1914.

2. *Time Service.*—No change has been made in the methods of determining time. In the time service the 8 A.M. signals to Colombo were discontinued on the 1st November, arrangements having been made there to determine time locally.

The Fort gun failed on 28 occasions out of 730, giving 96·2 as the percentage of success. From 1st January to 7th August there were no failures. Then there followed a series of failures, the cause of which—a contact on the line—was not discovered until as many as 23 had occurred. None of the failures were due to faults at the Observatory.

The semaphore at the Port office failed on six occasions. On three of these days it was correctly dropped at 2 P.M. It was dropped correctly at 1 P.M. on all other days. None of the failures were due to faults at the Observatory.

3. *Meteorological Observations.*—In addition to the ordinary meteorological observations, extra observations were taken for storm warning purposes and telegrams sent to Simla on two occasions and to Calcutta on 34 occasions. A new solar radiation thermometer was received from Calcutta and brought into use from 12th January 1914.

4. *Buildings.*—Some repairs to the office and quarters were carried out during the year.

With a view to increasing the steadiness of the transit circle, the Chief Engineer came and inspected the Observatory and the compound in February. He finally advised that a subsoil drain should be constructed round the building. Plans and estimates for this construction were accordingly drawn up, the estimates amounting to Rs. 2,880. This has been sanctioned by the Government of India ; the work had not been commenced at the end of the year.

5. *Instruments.*—The following is a list of the instruments at the Observatory on the 31st December 1914 :—

(a) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton & Simms.
Sidereal clock—Haswall.
Do. Dent, No. 1408.
Do. S. Riefler, No. 61.
Mean Time clock—J. H. Agar Baugh, No. 105.
Do. with galvanometer—Shepherd & Sons
Meridian circle—Troughton & Simms.
Portable transit instrument—Dolland.
Portable telescope with stand.
Tape chronograph—R. Fuess.
Relay for use with the Chronograph—Siemens.

(b) *Meteorological.*

Richard's barograph—No. 10, L. Casella.
Do. Thermograph—No. 29637, L. Casella.
Beckley's Anemograph—Adie.
Sunshine Recorder—No. 149, L. Casella.
Nephoscope—Mons Jules Daboseq & Ph. Pellin.
Barometer, Fortin's—No. 1771, L. Casella.
Do. do. No. 725, L. Casella (spare).
Do. do. No. 1420, L. Casella (spare).

Dry bulb thermometer—No. 94221, L. Casella.
Do. No. 38037, Negretti and Zambra (spare).
Wet do. do. No. 94219, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Dry Maximum thermometer—No. 8581, Negretti and Zambra.
Dry Minimum thermometer—No. 69017, L. Casella.
Wet Do. do. No. 91753, Negretti and Zambra.
Sun Maximum thermometer—No. 127618, Negretti and Zambra.
Grass Minimum thermometer—No. 3377, Negretti and Zambra.
Rain-gauge (8″ diameter)—No. 1042, Negretti and Zambra.
Measure glass for above.
Raingauge (5″ diameter).
Measure glass for above.

The Haswall and Agar Baugh clocks were cleaned during the year.

A new eyepiece for the Transit Instrument was received from Messrs. T. Cooke & Sons and was brought into use on the 29th July 1914.

The level of the Transit has during the year undergone large changes as usual. With the heavy rain in October and November a very rapid change occurred in the reverse direction to that which had taken place during the previous dry months.

6. *Weather Summary.*—The following is a summary of the meteorological conditions at Madras during 1914:—

*Pressure.*—Pressure was above normal in January, February, April, May, September and October and below normal during the other months. The greatest excess was 0·081 inch in October and the greatest defect 0·042 inch in July. The highest pressure recorded was 30·216 inches on January 9, and the lowest 29·511 inches on June 25.

*Temperature.*—The mean temperature of air was above normal in all months except April, September and October. The maximum shade temperature was also above normal in all months except January, February, April, August, September and October. The minimum in the shade was below normal in April, August, September and October and above normal in the remaining months. The highest shade temperature recorded was 110°·3 on June 1, and the lowest 60°·6 on December 24. The highest reading of the black bulb thermometer was 168°·6 on October 5 and the lowest on grass 56°·9 on December 24.

*Humidity.*—The percentage of humidity was normal in March, nearly normal in January, June and December and above normal in the remaining months.

*Wind.*—The wind direction was normal or nearly normal in all months except in February when it was two points more southerly, in July and August when it was two points more westerly and in October when it was two points more northerly. The amount of air movement was below normal in all months except January. This is undoubtedly largely due to change in exposure.

*Cloud.*—The percentage of cloud was above normal in April, May, July and October and below in the remaining months.

*Sunshine.*—The percentage of bright sunshine was above normal in February, April and September and below in the other months. There were 2207·0 hours of bright sunshine during the year.

*Rainfall.*—The rainfall was above the average in January, April and from August to November and below for the other months. The greatest excess was 8·22 inches in October and the greatest defect 4·51 inches in December. The total rainfall for the year was 56·63 inches against an average of 49·02 inches. The monsoon rainfall from October 15 to the end of the year was 31·74 inches against an average of 26·00 inches. The greatest fall on any day was 7·46 inches on November 1.

*Storm.*—A storm formed in the south-west of the bay on the 1st November 1914, moved in a westerly direction and passed inland to the south of Madras.

THE OBSERVATORY, MADRAS,
*27th January* 1915.

R. LL. JONES,
*Deputy Director.*

# APPENDIX I.

## STATION—KODAIKANAL OBSERVATORY.

### SEISMIC RECORDS.

$\phi = 10° 13' 50''$ N. $\lambda = 77° 28' 00''$ E. $h = 2343$ metres. *Subsoil*—Rock.
*Apparatus*—Milne's Horizontal Pendulum Seismograph.

| 1914. | $T_o$ | $\frac{r}{T_o^2}$ | 1914. | $T_o$ | $\frac{r}{T_o^2}$ |
|---|---|---|---|---|---|
| January ... ... | 16·0 | 3·5 | July ... ... | 16·7 | 2·8 |
| February ... ... | 16·0 | 3·2 | August ... ... | 16·8 | 2·9 |
| March ... ... | 16·0 | 3·4 | September ... | 16·3 | 3·2 |
| April ... ... | 16·3 | 3·0 | October ... ... | 16·1 | 3·3 |
| May ... ... | 16·6 | 3·2 | November ... ... | 15·3 | 3·4 |
| June ... ... | 16·4 | 2·9 | December ... ... | 15·7 | 3·8 |

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period. (Sec.) | Amplitude (u). $A_N$. | $A_E$. | $A_Z$. | Distance $\Delta$ (Km.) | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1914. | | | | | | | | | | |
| 1 | January 12 ... | eP | 9 | 49 | 18 | ... | ... | ... | ... | ... | |
| | | eL | 9 | 59 | 30 | ... | ... | .. | ... | ... | |
| | | M | 10 | 5 | 12 | | ... | 50 | ... | ... | |
| | | F | 10 | 23 | 6 | ... | ... | ... | ... | ... | |
| 2 | 15 ... | eP | 20 | 3 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 20 | 39 | 18 | ... | ... | ... | ... | ... | |
| 3 | 20 ... | eP | 12 | 22 | 18 | ... | ... | ... | ... | ... | |
| | | iL | 12 | 48 | 0 | ... | ... | .. | ... | ... | |
| | | M | 12 | 51 | 42 | ... | ... | 40 | ... | ... | |
| | | F | 13 | 9 | 48 | ... | ... | ... | ... | ... | |
| 4 | 30 ... | eP | 3 | 56 | 0 | ... | ... | ... | ... | ... | |
| | | iL | 4 | 49 | 48 | ... | .. | .. | ... | ... | |
| | | M | 5 | 1 | 12 | ... | ... | 260 | ... | ... | |
| | | | | 8 | 24 | ... | ... | 250 | | | |
| | | F | | ? | | ... | ... | ... | ... | ... | |
| 5 | February 4 ... | eP | 21 | 02 | 48 | ... | ... | ... | ... | ... | |
| | | F | 22 | 16 | 12 | ... | . | ... | ... | ... | Widening of line. |
| 6 | 6 ... | iP | 12 | 50 | 30 | ... | ... | ... | ... | ... | |
| | | iL | 12 | 53 | 36 | ... | ... | ... | ... | ... | |
| | | M | 12 | 58 | 42 | ... | ... | 35 | .. | ... | |
| | | F | 13 | 11 | 54 | ... | ... | ... | ... | ... | |
| 7 | 13 ... | eP | 1 | 47 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 2 | 10 | 18 | . | ... | ... | ... | ... | |
| 8 | 22 ... | eP | 23 | 20 | 54 | ... | ... | ... | ... | ... | |
| | | eL | 23 | 31 | 00 | ... | ... | ... | ... | ... | |
| | | M | 23 | 33 | 36 | ... | ... | 40 | ... | ... | |
| | | F | 23 | 53 | 48 | .. | ... | ... | ... | .. | |
| 9 | March 2 ... | eP | 0 | 41 | 18 | | ... | ... | ... | ... | Widening of line. |
| | | F | 1 | 12 | 00 | .. | ... | ... | ... | ... | |
| 10 | 2 ... | eP | 1 | 30 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 1 | 53 | 36 | ... | ... | ... | ... | .. | |
| 11 | 6 ... | eP | 19 | 49 | 0 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 20 | 23 | 18 | ... | .. | .. | | ... | |
| 12 | 6 ... | eP | 20 | 49 | 48 | | .. | ... | ... | ... | |
| | | L | 20 | 51 | 30 | ... | ... | ... | ... | ... | |
| | | M | 20 | 58 | 42 | | ... | 50 | ... | ... | |
| | | F | 20 | 59 | 42 | .. | ... | ... | ... | ... | |
| 13 | 14 ... | eP | 20 | 19 | 30 | ... | ... | ... | ... | ... | |
| | | eL | 20 | 26 | 54 | | . | ... | | ... | |
| | | M | 20 | 44 | 36 | . | ... | 50 | ... | ... | |
| | | F | 21 | 24 | 24 | . | . | ... | ... | ... | |
| 14 | 27 ... | eP | 1 | 40 | 6 | ... | ... | ... | ... | ... | |
| | | eL | 1 | 43 | 24 | .. | ... | ... | ... | ... | |
| | | M | 1 | 49 | 30 | ... | ... | 20 | ... | ... | |
| | | F | 2 | 00 | 6 | ... | ... | ... | | ... | |
| 15 | 28 ... | iP | 10 | 53 | 48 | ... | ... | ... | ... | . | |
| | | eL | 10 | 57 | 42 | ... | ... | ... | .. | ... | |
| | | M | 11 | 8 | 24 | .. | ... | 60 | ... | ... | |
| | | F | 11 | 36 | 6 | ... | ... | ... | ... | ... | |
| 16 | 30 ... | iP | 1 | 2 | 54 | ... | ... | ... | ... | ... | |
| | | iL | 1 | 12 | 54 | ... | ... | .. | ... | ... | |
| | | M | 1 | 25 | 30 | ... | ... | 70 | ... | ... | |
| | | F | | ... | | ... | ... | ... | ... | ... | |

Kodaikanal Observatory Seismic Records—*cont.*

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period. (Sec.) | Amplitude (u). An. | Ae. | Az. | Distance △ (Km.) | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1914. | | | | | | | | | | |
| 17 | March 30 ... | P | | | | ... | ... | ... | ... | ... | |
| | | eL | 2 | 1 | 6 | ... | ... | ... | ... | ... | |
| | | M | 2 | 38 | 0 | ... | ... | 60 | ... | ... | |
| | | F | 3 | 24 | 24 | ... | ... | ... | ... | ... | |
| 18 | April 11 ... | eP | 16 | 41 | 30 | ... | ... | ... | ... | ... | |
| | | iL | 16 | 52 | 00 | ... | ... | ... | ... | ... | |
| | | M | 17 | 24 | 00 | ... | ... | 140 | ... | ... | |
| | | F | 19 | 19 | 24 | ... | ... | ... | ... | ... | |
| 19 | 20 ... | eP | 14 | 55 | 54 | ... | ... | ... | ... | ... | |
| | | eL | 15 | 00 | 12 | ... | ... | ... | ... | ... | |
| | | M | 15 | 03 | 36 | ... | ... | 60 | ... | ... | |
| | | F | 15 | 45 | 6 | ... | ... | ... | ... | ... | |
| 20 | May 21 ... | eP | 8 | 35 | 24 | ... | ... | ... | ... | ... | |
| | | L | 8 | 38 | 42 | ... | ... | ... | ... | ... | |
| | | M | 8 | 39 | 12 | ... | ... | 50 | ... | ... | |
| | | F | 8 | 59 | 12 | ... | ... | ... | ... | ... | |
| 21 | 26 ... | eP | 1 | 12 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 1 | 38 | 42 | ... | ... | ... | ... | ... | |
| 22 | 26 ... | iL | 2 | 52 | 18 | ... | ... | ... | ... | ... | No. P. Ts. |
| | | M | 2 | 53 | 18 | ... | ... | 70 | ... | ... | |
| | | F | 3 | 2 | 48 | ... | ... | ... | ... | ... | |
| 23 | 26 .. | eP | 14 | 29 | 6 | ... | ... | ... | ... | ... | |
| | | iL | 14 | 35 | 0 | ... | ... | ... | ... | ... | |
| | | M { | 14 | 46 | 00 | ... | ... | 1,070 | ... | ... | |
| | | | 14 | 59 | 36 | ... | ... | 1,500 | ... | ... | |
| | | F | 18 | 19 | 48 | ... | ... | ... | ... | ... | |
| 24 | 29 ... | eP | 4 | 46 | ? | ... | ... | ... | ... | ... | |
| | | L | | ? | | ... | ... | ... | ... | ... | |
| | | M | 5 | 1 | 48 | ... | ... | 850 | ... | ... | Instrument examined at 4 *h*. 47*m*. |
| | | F | 6 | 46 | 12 | ... | ... | ... | ... | ... | |
| 25 | June 20 ... | eP | 7 | 43 | 36 | ... | ... | ... | ... | ... | |
| | | iL | 8 | 9 | 6 | ... | ... | ... | ... | ... | |
| | | M | 8 | 23 | 36 | ... | ... | 270 | ... | ... | |
| | | F | 9 | 59 | 42 | ... | ... | ... | ... | ... | |
| 26 | 20 ... | eP | 11 | 20 | 18 | ... | ... | ... | ... | ... | |
| | | eL | 11 | 26 | 54 | ... | ... | ... | ... | ... | |
| | | M | 11 | 26 | 54 | ... | ... | 50 | ... | ... | |
| | | F | 11 | 54 | 6 | ... | ... | ... | ... | ... | |
| 27 | 25 ... | iL | 19 | 12 | 42 | ... | ... | ... | ... | ... | No. P. Ts. |
| | | M | 19 | 25 | 12 | ... | ... | 900 | ... | ... | |
| | | F | | ? | | ... | ... | ... | ... | ... | |
| 28 | 26 ... | eP | 5 | 14 | 48 | ... | ... | ... | ... | ... | End lost in air tremors. |
| | | eL | 5 | 38 | 36 | ... | ... | ... | ... | ... | |
| | | M | 5 | 53 | 48 | ... | ... | 150 | ... | ... | |
| | | F | | ? | | ... | ... | ... | ... | ... | |
| 29 | 26 ... | P | | ? | | ... | ... | ... | ... | ... | |
| | | eL | 6 | 52 | 0 | ... | ... | ... | ... | ... | |
| | | M | 6 | 56 | 36 | ... | ... | 40 | ... | ... | |
| | | F | 7 | 15 | 24 | ... | ... | ... | ... | ... | |
| 30 | July 4 ... | eP | 17 | 00 | 12 | ... | ... | ... | ... | ... | |
| | | iL | 17 | 01 | 48 | ... | ... | ... | ... | ... | |
| | | M | 17 | 10 | 24 | ... | ... | 60 | ... | ... | |
| | | F | 17 | 35 | 36 | ... | ... | ... | ... | ... | |
| 31 | 4 ... | eP | 22 | 47 | 24 | ... | ... | ... | ... | ... | |
| | | F | 23 | 39 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| 32 | 6 ... | eP | 6 | 52 | 06 | ... | ... | ... | ... | ... | |
| | | eL | 7 | 05 | 30 | ... | ... | ... | ... | ... | |
| | | M | 7 | 08 | 00 | ... | ... | 30 | ... | ... | |
| | | F | 7 | 15 | 36 | ... | ... | ... | ... | ... | |
| 33 | 14 ... | eP | 3 | 16 | 54 | ... | ... | ... | ... | ... | |
| | | iL | 3 | 22 | 42 | ... | ... | ... | ... | ... | |
| | | M | 3 | 30 | 48 | ... | ... | 270 | ... | ... | |
| | | F | 4 | 23 | 36 | ... | ... | ... | ... | ... | |
| 34 | 17 ... | eP | 7 | 33 | 06 | ... | ... | ... | ... | ... | |
| | | eL | 7 | 59 | 42 | ... | ... | ... | ... | ... | |
| | | M | 8 | 08 | 42 | ... | ... | 30 | ... | ... | |
| | | F | 8 | 38 | 42 | ... | ... | ... | ... | ... | |
| 35 | 25 ... | eP | 21 | 46 | 54 | ... | ... | ... | ... | ... | |
| | | iL | 21 | 51 | 30 | ... | ... | ... | ... | ... | |
| | | M | 21 | 54 | 06 | ... | ... | 170 | ... | ... | |
| | | F | 22 | 17 | 42 | ... | ... | ... | ... | ... | |
| 36 | August 4 ... | eP | 4 | 28 | 18 | ... | ... | ... | ... | ... | |
| | | eL | 4 | 30 | 06 | ... | ... | ... | ... | ... | |
| | | M | 4 | 32 | 06 | ... | ... | 70 | ... | ... | |
| | | F | 4 | 38 | 18 | ... | ... | ... | ... | ... | |
| 37 | 4–5 ... | eP | 22 | 53 | 48 | ... | ... | ... | ... | ... | |
| | | eL | 22 | 54 | 36 | ... | ... | ... | ... | ... | |
| | | M | 23 | 01 | 18 | ... | ... | 1,300 | ... | ... | |
| | | F | 0 | 58 | 42 | ... | ... | ... | ... | ... | |

## Kodaikanal Observatory Seismic Records—*concld.*

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period. (Sec.) | Amplitude (u) An. | Ae. | Az. | Distance △ (Km.) | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1914. | | | | | | | | | | |
| 38 | August 5 ... | eP | 10 | 53 | 48 | ... | ... | ... | ... | ... | |
| | | eL | 10 | 54 | 36 | .. | ... | ... | ... | .. | |
| | | M | 10 | 56 | 06 | ... | ... | 70 | ... | ... | |
| | | F | 11 | 14 | 36 | ... | ... | ... | . | ... | |
| 39 | 6 ... | eP | 4 | 14 | 54 | ... | ... | ... | ... | ... | Instrument examined at 4h 16m. |
| | | F | 5 | 04 | 24 | ... | ... | ... | .. | ... | |
| 40 | 16–17 ... | eP | 23 | 35 | 54 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 0 | 20 | 12 | ... | ... | ... | ... | ... | |
| 41 | 28 ... | eP | 6 | 42 | 00 | ... | ... | ... | ... | ... | |
| | | eL | 6 | 44 | 42 | . | ... | ... | ... | ... | |
| | | M | 6 | 53 | 24 | ... | ... | 40 | ... | ... | |
| | | F | 7 | 18 | 36 | ... | ... | ... | ... | ... | |
| 42 | September 23 ... | eP | 2 | 17 | 42 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 2 | 29 | 00 | ... | ... | ... | .. | ... | |
| 43 | 26 ... | eP | 5 | 17 | 42 | ... | ... | ... | .. | .. | |
| | | iL | 5 | 18 | 30 | .. | ... | ... | ... | ... | |
| | | M | 5 | 20 | 30 | ... | .. | 40 | ... | ... | |
| | | F | | ? | | .. | ... | ... | ... | ... | Instrument examined at 5h 34m. |
| 44 | October 3 ... | eP | 17 | 44 | 06 | ... | .. | ... | ... | ... | |
| | | iL | 18 | 30 | 00 | ... | ... | ... | ... | ... | |
| | | M | 18 | 40 | 48 | ... | ... | 70 | ... | ... | |
| | | | | 43 | 48 | ... | ... | 70 | ... | ... | |
| | | F | 19 | 34 | 48 | ... | ... | ... | ... | ... | |
| 45 | 3 ... | eP | 22 | 18 | 42 | . | ... | ... | ... | ... | |
| | | iL | 22 | 27 | 18 | .. | .. | ... | ... | ... | |
| | | M | 22 | 40 | 48 | ... | ... | 500 | ... | ... | |
| | | F | 23 | 50 | 12 | ... | ... | ... | ... | ... | |
| 46 | 6 ... | eP | 20 | 02 | 54 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 20 | 38 | 42 | ... | ... | . | ... | ... | |
| 47 | 9 ... | P | | | | ... | ... | ... | ... | ... | No. P. Ts. |
| | | iL | 2 | 48 | 36 | ... | .. | ... | ... | ... | |
| | | M | 2 | 51 | 42 | ... | ... | 1,080 | ... | ... | |
| | | F | 3 | 46 | 48 | ... | ... | ... | ... | ... | |
| 48 | 11 ... | eP | 16 | 24 | 48 | ... | ... | ... | ... | ... | |
| | | eL | 16 | 31 | 12 | ... | ... | ... | ... | ... | |
| | | M | 16 | 27 | 51 | ... | ... | 50 | ... | ... | |
| | | F | 16 | 35 | 48 | ... | ... | ... | ... | ... | |
| 49 | 23 ... | eP | 6 | 28 | 18 | ... | ... | . | ... | ... | |
| | | iL | 6 | 34 | 42 | ... | ... | . | ... | ... | |
| | | M | 6 | 40 | 18 | ... | ... | 500 | ... | ... | |
| | | F | 7 | 38 | 18 | ... | ... | .. | ... | ... | |
| 50 | November 4 ... | eP | 8 | 30 | 00?* | .. | ... | ... | ... | ... | Widening of line. |
| 51 | 4 ... | eP | 9 | 01 | 30 | ... | ... | ... | ... | ... | Do. |
| | | F | 9 | 18 | 06 | ... | ... | ... | ... | ... | |
| 52 | 4 ... | eP | 11 | 01 | 00 | ... | ... | ... | ... | ... | |
| | | eL | 11 | 16 | 54 | ... | ... | ... | ... | ... | |
| | | M | 11 | 22 | 48 | ... | .. | 50 | ... | ... | |
| | | F | 11 | 46 | 24 | .. | ... | ... | ... | ... | |
| 53 | 10 ... | eP | 6 | 54 | 30 | ... | ... | ... | ... | .. | |
| | | eL | 7 | 27 | 54 | ... | ... | ... | ... | ... | |
| | | M | 7 | 45 | 00 | ... | ... | 30 | ... | ... | |
| | | F | 8 | 01 | 00 | ... | ... | .. | .. | ... | |
| 54 | 18 ... | eP | 10 | 41 | 48 | ... | ... | ... | ... | ... | |
| | | eL | 11 | 08 | 30 | .. | ... | ... | . | ... | |
| | | M | 11 | 20 | 30 | ... | ... | 50 | ... | ... | |
| | | F | 11 | 44 | 54 | ... | ... | ... | ... | ... | |
| 55 | 24 ... | P | | | | ... | ... | ... | ... | ... | No P. Ts. |
| | | iL | 12 | 04 | 12 | ... | ... | ... | ... | ... | |
| | | M | 12 | 32 | 18 | ... | ... | 80 | ... | ... | |
| | | F | 13 | 44 | 54 | ... | .. | ... | .. | ... | |
| 56 | 27 ... | eP | 15 | 14 | 30 | .. | ... | ... | .. | ... | Widening of line. |
| | | F | 15 | 21 | 12 | ... | ... | ... | ... | ... | |
| 57 | 28 ... | eP | 10 | 58 | 12 | . | ... | ... | ... | ... | |
| | | iL | 11 | 19 | 18 | ... | ... | ... | ... | ... | |
| | | M | 11 | 28 | 12 | .. | ... | 70 | ... | ... | |
| | | F | 11 | 52 | 54 | ... | ... | ... | . | ... | |
| 58 | 29 ... | P | 5 | 12 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 5 | 30 | 00 ? | ... | ... | ... | ... | ... | End lost in hour mark. |
| 59 | December 9 ... | eP | 6 | 05 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 6 | 09 | 42 | ... | ... | ... | ... | ... | |
| 60 | 20 ... | eP | 14 | 34 | 24 | ... | ... | ... | ... | ... | |
| | | iL | 14 | 38 | 00 | ... | ... | ... | ... | ... | |
| | | M | 14 | 38 | 54 | ... | ... | 50 | ... | ... | |
| | | F | 16 | 34 | 36 | ... | ... | ... | ... | .. | |

* Merged in hour mark. Lasted about two minutes.

# APPENDIX II.

Latitude 10° 13′ 50″ N.
Longitude $5^h$ $9^m$ $52^s$ E.

Height of Barometer cistern above mean sea level 7,688 feet.

## Mean Monthly and Annual Meteorological Results at the Kodaikanal Observatory in 1914.

| Month. | Barometer. | | Dry Bulb Thermometer. | | | | Wet Bulb. | | Tension of Vapour. | Relative Humidity. | Sun Max. in Vac. | Min. on Grass | Wind. | | | Rain. | | Clear Sky. | Bright Sun-shine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reduced to 32°. | Daily Range. | Mean. | Max. | Min. | Range. | Mean. | Min. | By Blanford's Tables. | | | | Daily Velo-city. | Mean Direction. | | Amount. | Days. | | |
| | Inches. | Inches. | ° | ° | ° | ° | ° | ° | Inches. | Cents. | ° | ° | Miles. | Points. | | Inches. | No. | Cents. | Hours. |
| January ... | 22·889 | 0·060 | 57·0 | 67·2 | 46·8 | 20·4 | 46·8 | 38·7 | 0·227 | 50 | 127·1 | 36·8 | 287 | 8 | E. | 0 50 | 2 | 67 | 280·4 |
| February ... | ·883 | ·063 | 58·9 | 70·2 | 47·6 | 22 6 | 47·7 | 39·9 | ·235 | 48 | 132·2 | 36·6 | 268 | 8 | E. | 0·14 | 1 | 74 | 279·5 |
| March ... | ·873 | ·068 | 60·5 | 70·4 | 50·7 | 19·7 | 51 0 | 43·7 | ·292 | 57 | 138·3 | 41·3 | 267 | 7 | E. by N. | 3 94 | 3 | 60 | 270·4 |
| April ... | ·861 | ·063 | 61·4 | 70·2 | 52·7 | 17·5 | 54·1 | 48·0 | ·360 | 69 | 140·6 | 43·2 | 221 | 8 | E. | 3 46 | 9 | 52 | 241·2 |
| May ... | ·835 | ·065 | 62·2 | 69·8 | 54·6 | 15·2 | 55·8 | 50·5 | ·392 | 73 | 135·6 | 47·2 | 169 | 2 | N.N.E. | 11·27 | 14 | 35 | 201·7 |
| June ... | ·777 | ·055 | 60 0 | 66·1 | 54·0 | 12·1 | 54·4 | 49·9 | ·383 | 78 | 131·7 | 49·0 | 349 | 25 | W. by N. | 2·49 | 9 | 21 | 149 6 |
| July ... | ·737 | ·051 | 56·9 | 61·3 | 52·3 | 9·0 | 53·5 | 50·5 | ·385 | 86 | 120·7 | 50 4 | 507 | 25 | W. by N. | 3·62 | 13 | 5 | 75·2 |
| August ... | ·788 | ·058 | 57·8 | 63·3 | 52·4 | 10·9 | 53·5 | 49·6 | ·374 | 80 | 128·5 | 49·9 | 389 | 26 | W.N.W. | 5·50 | 11 | 20 | 158·2 |
| September ... | ·811 | ·073 | 58·9 | 65·4 | 52 5 | 12 9 | 55·3 | 50·9 | ·411 | 86 | 131·6 | 48·6 | 213 | 24 | W. | 13·60 | 19 | 27 | 174·4 |
| October ... | ·853 | ·075 | 57·0 | 62·4 | 51·6 | 10·8 | 54·2 | 50·3 | ·404 | 90 | 121·4 | 48·3 | 243 | 6 | E.N.E. | 15·89 | 22 | 15 | 100 5 |
| November ... | ·825 | ·068 | 56·3 | 63·2 | 49·4 | 13·8 | 52.5 | 46·9 | ·367 | 82 | 122·2 | 44·4 | 241 | 1 | N. by E. | 7·47 | 8 | 38 | 188·9 |
| December ... | 847 | ·065 | 56·3 | 63·1 | 49·5 | 13·6 | 50·8 | 45·5 | ·328 | 74 | 114·9 | 43·5 | 306 | 4 | N.E. | 11·78 | 9 | 45 | 184·5 |
| Annual ... | 22·832 | 0·064 | 58·6 | 66·1 | 51·2 | 14·9 | 52·5 | 47·0 | 0·347 | 73 | 128·7 | 44·9 | 288 | 2 | N.N.E. | 79 66 | 120 | 38 | 2304·5 |

## Extreme Monthly Meteorological Records at the Kodaikanal Observatory in 1914.

| Month. | Barometer. | | | | | Dry Bulb Thermometer. | | | | Wet Bulb. | | Humidity. | | Sun Th. in Vacuo. | | Grass Therm. | | Wind. | | | | Rain. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | | Lowest. | | Range. | Highest. | | Lowest. | | Lowest. | | Lowest. | | Highest. | | Lowest. | | Highest. | | Lowest. | | Greatest Fall. | |
| | Inches. | Day. | Inches. | Day. | Inches. | ° | Day. | ° | Day. | ° | Day. | Cents. | Day. | ° | Day. | ° | Day. | Miles. | Day. | Miles. | Day. | Inches. | Day. |
| January ... | 22·986 | 8 | 22·786 | 21 | 0·200 | 75·8 | 28 | 40·7 | 1 | 33·2 | 29 | 7 | 28 | 138·1 | 6 | 24.8 | 29 | 468 | 16 | 146 | 3 | 0·25 | 8 |
| February ... | ·966 | 21 | ·790 | 2 | ·176 | 76·2 | 21 | 41·0 | 4 | 30 7 | 4 | 11 | 19 | 142·0 | 26 | 21·5 | 4 | 478 | 3 | 160 | 16 | 0·14 | 15 |
| March ... | ·962 | 19 | ·785 | 6 | ·177 | 75·3 | 3, 14 | 47 0 | 29 | 32·6 | 5 | 7 | 5 | 148·6 | 14 | 34 3 | 29 | 538 | 29 | 145 | 23 | 3·26 | 8 |
| April ... | ·940 | 10 | ·785 | 1 | ·155 | 75·6 | 29 | 49·9 | 6 | 41·6 | 7 | 33 | 25 | 150·8 | 24 | 32·3 | 29 | 368 | 21 | 103 | 3 | 0·81 | 13 |
| May ... | ·938 | 19 | ·750 | 13 | ·188 | 74·9 | 23 | 51·9 | 20 | 45·3 | 19 | 36 | 23 | 144·2 | 23 | 42·3 | 2 | 313 | 10 | 38* | 29 | 1·75 | 6 |
| June ... | ·851 | 1 | ·692 | 13 | ·159 | 72·4 | 3 | 52·5 | 21 | 43·7 | 17 | 48 | 17 | 143 7 | 5 | 43·3 | 17 | 532 | 6 | 125 | 3 | 0·33 | 13 |
| July ... | ·824 | 16 | ·643 | 27 | ·181 | 68·3 | 1 | 49·4 | 25, 26 | 48·1 | 23 | 51 | 28 | 143 1 | 3 | 47·8 | 18, 23 | 735 | 9 | 217 | 30, 31 | 0·57 | 15 |
| August ... | ·880 | 9 | ·665 | 17 | ·215 | 67·1 | 22 | 50·0 | 6 | 43·2 | 21 | 33 | 21 | 143·9 | 8 | 45·2 | 10 | 594 | 21 | 110 | 31 | 1·53 | 12 |
| September ... | 920 | 20 | ·694 | 14 | ·226 | 70·1 | 30 | 50·4 | 14 | 47·5 | 14 | 64 | 22 | 142·3 | 27 | 45 0 | 16 | 476 | 4 | 86* | 8 | 4·10 | 20 |
| October ... | ·936 | 19, 25 | ·756 | 6 | ·180 | 66·6 | 1 | 48 3 | 18 | 44·3 | 3 | 58 | 3 | 140·9 | 1 | 44 0 | 22 | 548 | 13 | 119 | 5 | 2·23 | 1 |
| November ... | ·906 | 27 | ·732 | 18 | ·174 | 68·5 | 11 | 42·9 | 24 | 35·3 | 20 | 34 | 20 | 137·3 | 20 | 30·3 | 20 | 440 | 28 | 110 | 24 | 2·64 | 29 |
| December ... | ·942 | 28 | ·736 | 20 | ·206 | 70·3 | 28 | 42·1 | 27 | 31·7 | 25 | 11 | 27 | 131·9 | 16 | 20·4 | 27 | 656 | 19 | 116 | 12 | 3·01 | 6 |

# APPENDIX III.

KODAIKANAL mean hourly wind velocity for the year 1914.

| Month. | Hours. | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| January ... | 12 | 12 | 12 | 13 | 13 | 14 | 13 | 13 | 12 | 12 | 14 | 14 | 14 | 13 | 12 | 10 | 9 | 8 | 9 | 10 | 11 | 11 | 12 | 13 |
| February ... | 12 | 12 | 12 | 13 | 12 | 12 | 12 | 11 | 11 | 12 | 13 | 13 | 13 | 11 | 11 | 10 | 9 | 9 | 9 | 8 | 8 | 10 | 12 | 12 |
| March ... | 11 | 11 | 11 | 11 | 11 | 12 | 13 | 13 | 13 | 14 | 14 | 14 | 12 | 11 | 9 | 9 | 8 | 8 | 9 | 10 | 9 | 9 | 10 | 12 |
| April ... | 9 | 11 | 9 | 10 | 10 | 10 | 10 | 11 | 10 | 11 | 10 | 9 | 9 | 9 | 9 | 8 | 6 | 7 | 8 | 9 | 9 | 8 | 8 | 10 |
| May ... | 8 | 7 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 8 | 8 | 8 | 9 | 8 | 8 | 7 | 7 | 7 | 6 | 7 | 8 | 8 | 8 |
| June ... | 17 | 15 | 15 | 16 | 16 | 15 | 15 | 12 | 13 | 12 | 13 | 12 | 12 | 12 | 12 | 12 | 13 | 15 | 16 | 17 | 18 | 18 | 18 | 17 |
| July ... | 24 | 21 | 23 | 23 | 23 | 23 | 22 | 21 | 18 | 20 | 18 | 18 | 18 | 18 | 18 | 19 | 19 | 21 | 23 | 23 | 23 | 23 | 24 | 24 |
| August ... | 18 | 18 | 18 | 18 | 18 | 17 | 16 | 16 | 15 | 15 | 15 | 13 | 13 | 13 | 13 | 14 | 14 | 15 | 17 | 18 | 18 | 18 | 19 | 19 |
| September ... | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 8 | 8 | 9 | 9 | 10 | 10 | 9 | 10 | 10 | 9 | 9 | 10 | 10 | 9 | 9 | 9 | 8 |
| October ... | 11 | 10 | 10 | 10 | 10 | 10 | 11 | 10 | 11 | 12 | 11 | 10 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 10 | 11 | 10 |
| November ... | 11 | 10 | 11 | 11 | 11 | 11 | 11 | 11 | 10 | 12 | 11 | 11 | 10 | 10 | 9 | 8 | 7 | 8 | 8 | 9 | 9 | 10 | 11 | 11 |
| December ... | 14 | 13 | 13 | 13 | 12 | 12 | 12 | 13 | 14 | 14 | 14 | 15 | 14 | 13 | 12 | 12 | 10 | 10 | 11 | 13 | 13 | 13 | 13 | 13 |
| Annual ... | 13 | 12 | 12 | 13 | 13 | 12 | 13 | 12 | 12 | 12 | 13 | 12 | 12 | 11 | 11 | 11 | 10 | 10 | 11 | 12 | 12 | 12 | 13 | 13 |

## APPENDIX IV.

KODAIKANAL mean hourly bright sunshine for the year 1914.

| Month. | Hours. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6-7 | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 |
| January ... ... .. | 0·31 | 0·77 | 0·82 | 0·86 | 0·86 | 0·86 | 0·89 | 0·85 | 0·86 | 0·86 | 0·78 | 0·33 |
| February ... ... ... | ·51 | ·95 | ·97 | ·99 | ·99 | 1·00 | ·94 | ·93 | ·84 | ·75 | ·73 | ·39 |
| March ... ... ... ... | ·63 | ·98 | ·97 | ·95 | ·92 | 0·83 | ·75 | ·69 | ·56 | ·53 | ·50 | ·42 |
| April ... ... .. .. | ·67 | ·94 | ·96 | ·97 | ·95 | ·89 | ·72 | ·47 | ·50 | ·40 | .29 | ·28 |
| May ... ... ... .. | ·37 | ·70 | ·78 | ·78 | ·87 | ·80 | ·61 | ·55 | ·39 | ·28 | ·25 | ·14 |
| June ... ... ... ... | ·23 | ·50 | ·58 | ·65 | ·68 | 62 | ·56 | ·43 | ·36 | ·22 | ·20 | ·12 |
| July ... ... ... . | ·10 | ·26 | ·32 | ·38 | ·36 | ·37 | ·33 | ·27 | ·22 | ·12 | ·04 | ... |
| August ... ... ... ... | ·19 | ·44 | ·58 | ·77 | ·78 | ·63 | ·53 | ·48 | ·37 | ·24 | ·08 | 02 |
| September ... ... ... | ·21 | ·56 | ·74 | ·79 | ·77 | ·80 | ·58 | ·42 | ·39 | ·34 | ·15 | ·04 |
| October .. ... ... ... | ·17 | ·27 | ·42 | ·38 | ·41 | ·35 | ·23 | ·29 | ·25 | ·19 | ·16 | ·02 |
| November ... . ... | ·14 | ·53 | ·75 | ·79 | ·77 | ·74 | ·66 | ·58 | ·47 | ·51 | ·32 | ·05 |
| December ... ... ... | ·08 | ·54 | ·66 | ·67 | ·64 | ·62 | ·59 | ·60 | ·63 | ·51 | ·30 | ·04 |
| Mean ... | 0·30 | 0·63 | 0·71 | 0·75 | 0·75 | 0·71 | 0·62 | 0·55 | 0·49 | 0·41 | 0·32 | 0·17 |

## APPENDIX V.

NUMBER of days in each month on which the Nilgiris were visible in 1914.

| Month. | Very clear. | Visible. | Just visible. | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January ... ... | ... | 15 | 7 | 3 | 25 |
| February ... ... | 2 | 5 | 5 | 1 | 13 |
| March ... ... | ... | 3 | 1 | ... | 4 |
| April ... .. | ... | ... | 3 | ... | 3 |
| May ... ... | ... | ... | 3 | ... | 3 |
| June .. ... | 1 | 4 | 2 | .. | 7 |
| July ... ... | ... | | 1 | 2 | 3 |
| August ... ... | 2 | 1 | ... | ... | 3 |
| September ... | 3 | 6 | ... | ... | 9 |
| October ... ... | 1 | 2 | ... | ... | 3 |
| November ... | 3 | 2 | 2 | 1 | 8 |
| December ... ... | 1 | 12 | 1 | ... | 14 |
| Total ... | 13 | 50 | 25 | 7 | 95 |

# APPENDIX VI.

MADRAS OBSERVATORY—Abnormals from monthly means for the year 1914.

| Abnormals of | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure ... ... ... | + 0·072 | + 0·023 | − 0·014 | + 0·046 | + 0·008 | − 0·011 | − 0·042 | − 0·003 | + 0·015 | + 0·081 | − 0·015 | − 0·015 | + 0·015 |
| Temperature of air ... ... ... .. ... | + 0·6 | + 0·7 | + 1·8 | − 0·7 | + 1·7 | + 2·0 | + 1·2 | + 0·1 | − 0·1 | − 0·2 | + 0·9 | + 1·6 | + 0·8 |
| Do. of evaporation ... ... ... | + 0·4 | + 0·7 | + 1·8 | + 0·8 | + 1·6 | + 0·2 | + 1·1 | + 1·2 | + 2·0 | + 1·1 | + 1·6 | + 1·2 | + 1·2 |
| Percentage of humidity ... ... ... ... | − 1 | + 1 | Same as | + 5 | + 1 | − 1 | + 1 | + 5 | + 9 | + 6 | + 3 | − 1 | + 2 |
| Greatest solar heat in *vacuo* ... ... ... | + 9·9 | + 10·2 | + 12·7 | + 10·6 | + 9·1 | + 9·7 | + 1·0 | + 5·3 | + 8·1 | + 7·5 | + 5·3 | + 11·5 | + 8·4 |
| Maximum in shade ... ... ... ... ... | − 1·0 | − 0·1 | + 1·2 | − 2·1 | + 2·7 | + 3·4 | + 1·0 | − 0·5 | − 1·4 | − 1·5 | + 0·1 | + 1·6 | + 0·3 |
| Minimum in shade ... ... ... ... ... | + 0·4 | + 0·6 | + 1·8 | − 0·4 | + 1·2 | + 2·0 | + 1·1 | − 0·2 | − 0·5 | − 0·1 | + 0·7 | + 1·0 | + 0·6 |
| Do. on grass ... ... ... .. ... | + 0·9 | + 1·7 | + 3·0 | + 0·5 | + 2·0 | + 2·6 | + 1·8 | + 0·6 | + 0·1 | + 0·8 | + 1·2 | + 2·0 | + 1·5 |
| Rainfall in inches ... ... ... ... ... | + 0·17 | − 0·28 | − 0·39 | + 1·43 | − 2·11 | − 1·47 | − 1·27 | + 4·85 | + 2·15 | + 8·22 | + 0·82 | − 4·51 | ... |
| Do. since January 1st ... ... ... ... | ... | − 0·11 | − 0·50 | + 0·93 | − 1·18 | − 2·65 | − 3·92 | + 0·93 | + 3·08 | + 11·30 | + 12·12 | + 7·61 | + 7·61 |
| General direction of wind ... ... .. ... | 1 point N. | 2 points S. | Same as | Same as | Same as | 1 point S. | 2 points W. | 2 points W. | 1 point S. | 2 points N. | 1 point E. | 1 point E. | Same as |
| Daily velocity in miles ... ... ... ... | + 13 | − 10 | − 7 | − 24 | − 30 | − 24 | − 17 | − 34 | − 20 | − 11 | − 21 | − 26 | − 18 |
| Percentage of cloudy sky ... ... ... ... | − 8 | − 8 | − 11 | + 8 | + 1 | − 15 | + 11 | − 2 | − 13 | + 6 | − 5 | − 10 | − 5 |
| Do. of bright sunshine ... ... ... | − 4·6 | + 1·1 | − 3·8 | + 3·2 | − 10·4 | − 1·2 | − 12·5 | − 4·2 | + 5·7 | − 15·3 | − 1·3 | − 1·5 | − 8·4 |

+ means above normal; — means below normal.

## APPENDIX VII.

ABSTRACT of the mean meteorological condition of Madras in the year 1914 compared with the average of past years.

| Mean values of | 1914. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure ... ... ... ... ... | 29·879 | 0·015 above. | 29·864 |
| Temperature of air ... ... ... ... ... ... .. | 81·9 | 0·8 „ | 81·1 |
| Do. of evaporation ... ... ... ... ... | 75·7 | 1·2 „ | 74·5 |
| Percentage of humidity ... ... ... ... ... ... | 74 | 2 „ | 72 |
| Greatest solar heat in *vacuo* ... ... ... ... ... | 148·1 | 8·4 „ | 139·7 |
| Maximum in shade ... ... ... ... ... ... ... | 91·1 | 0·3 „ | 90·8 |
| Minimum in shade ... ... ... .. ... .. ... | 75·3 | 0·6 „ | 74·7 |
| Do. on grass ... ... ... ... .. ... .. | 73·4 | 1·5 „ | 71·9 |
| Rainfall since January 1st on 95 days .. ... ... | 56·63 | 7·61 „ | 49·02 |
| General direction of wind .. ... ... ... ... ... | S.E. | Same as | S.E. |
| Daily velocity in miles ... ... ... ... ... ... | 153 | 18 below | 171 |
| Percentage of cloudy sky ... ... ... ... ... ... | 44 | 5 above. | 49 |
| Do. of bright Sunshine ... ... ... ... ... | 50·0 | 8·4 „ | 58·4 |

DURATION and Quantity of the Wind from different Points.

| From. | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North ... | 160 | 1,244 | East ... | 181 | 806 | South ... | 180 | 1,368 | West ... | 241 | 1,916 |
| N. by E. ... | 299 | 1,833 | E. by S.... | 186 | 949 | S. by W. | 216 | 1,423 | W. by N. | 222 | 1,636 |
| N.N.E. ... | 399 | 2,245 | E.S.E. ... | 201 | 970 | S.S.W. .. | 199 | 1,402 | W.N.W.... | 120 | 885 |
| N.E. by N.... | 819 | 4,887 | S.E. by E. | 272 | 1,514 | S.W. by S. | 274 | 1,689 | N.W. by W. | 74 | 507 |
| N.E. ... | 419 | 2,814 | S.E. ... | 495 | 3,034 | S.W. . | 242 | 1,525 | N.W. ... | 59 | 302 |
| N.E. by E.... | 337 | 2,115 | S.E. by S. | 885 | 6,419 | S.W. by W. | 216 | 1,399 | N.W. by N. | 29 | 104 |
| E.N.E. ... | 149 | 834 | S.S.E. ... | 497 | 4,115 | W.S.W. .. | 181 | 1,344 | N.N.W. ... | 7 | 43 |
| E. by N. ... | 303 | 1,392 | S. by E.... | 314 | 2,196 | W. by S. | 309 | 2,279 | N. by W. | 117 | 708 |

There were 158 calm hours during the year. The resultant corresponding to the above numbers is represented by a S.E. wind, blowing with a uniform daily velocity of 33 miles.

# APPENDIX VIII.

MADRAS OBSERVATORY—Number of hours of wind from each point in the year 1914.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January ... | 6 | 21 | 45 | 342 | 156 | 125 | 22 | 21 | 5 | 1 | ... | ... | ... | ... | ... | ... | ... | ... | .. | .. | ... | ... | ... | ... | ... | .. | ... | ... | ... | ... | ... | ... | ... |
| February ... | ... | ... | | 2 | 28 | 37 | 35 | 123 | 49 | 69 | 20 | 16 | 78 | 118 | 9 | 49 | 6 | 6 | 2 | 1 | 1 | 1 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 22 |
| March ... | ... | ... | ... | ... | ... | ... | ... | 30 | 53 | 33 | 60 | 122 | 72 | 229 | 54 | 14 | 8 | 10 | 9 | 8 | 1 | 1 | 1 | ... | ... | ... | ... | ... | ... | .. | ... | .. | 39 |
| April ... | .. | 2 | ... | 1 | 1 | 1 | 1 | ... | 1 | 1 | 4 | 58 | 185 | 290 | 85 | 12 | 17 | 19 | 19 | 3 | ... | ... | ... | ... | ... | .. | 1 | ... | ... | ... | 1 | 6 | 12 |
| May ... ... | 1 | 4 | 1 | ... | .. | 2 | 3 | ... | 4 | 10 | 44 | 24 | 60 | 76 | 118 | 77 | 41 | 63 | 48 | 48 | 27 | 21 | 20 | 9 | 9 | 10 | 8 | 6 | 2 | 1 | ... | 1 | 6 |
| June ... ... | 5 | 2 | 8 | 1 | 1 | ... | ... | 5 | 7 | 17 | 17 | 17 | 28 | 71 | 43 | 57 | 48 | 28 | 8 | 42 | 32 | 32 | 53 | 45 | 36 | 56 | 25 | 21 | 8 | 3 | 2 | 1 | 1 |
| July ... ... | 1 | ... | ... | ... | ... | ... | ... | | ... | 6 | ... | ... | 4 | 17 | 23 | 10 | 8 | 32 | 27 | 61 | 77 | 93 | 53 | 118 | 85 | 40 | 37 | 11 | 18 | 9 | 1 | 7 | 6 |
| August ... | ... | ... | . | 1 | 1 | ... | 1 | ... | 2 | 14 | 8 | 13 | 14 | 4 | 36 | 22 | 25 | 82 | 37 | 60 | 44 | 32 | 37 | 107 | 83 | 77 | 27 | 27 | 16 | 10 | 1 | 5 | 8 |
| September ... | 1 | 1 | 1 | 1 | ... | ... | ... | 1 | 1 | 8 | 9 | 10 | 47 | 63 | 102 | 69 | 26 | 23 | 46 | 50 | 60 | 36 | 14 | 30 | 27 | 35 | 19 | 7 | 11 | 6 | .. | .. | 16 |
| October ... | 11 | 73 | 60 | 150 | 62 | 47 | 41 | 96 | 41 | 23 | 33 | 5 | 2 | 17 | 27 | 4 | 1 | 3 | 3 | 1 | ... | ... | 3 | ... | 1 | 3 | 2 | 2 | 2 | ... | .. | 5 | 26 |
| November .. | 113 | 123 | 111 | 107 | 72 | 36 | 44 | 24 | 16 | 3 | 6 | 7 | 5 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | .. | 1 | 36 | 16 |
| December ... | 22 | 73 | 173 | 214 | 98 | 89 | 2 | 3 | 2 | 1 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | .. | ... | ... | .. | 1 | 1 | ... | 2 | ... | 1 | 56 | 6 |
| Annual total. | 160 | 299 | 399 | 819 | 419 | 337 | 149 | 303 | 181 | 186 | 201 | 272 | 495 | 885 | 497 | 514 | 180 | 216 | 199 | 274 | 242 | 216 | 181 | 309 | 241 | 222 | 120 | 74 | 59 | 29 | 7 | 117 | 158 |

# APPENDIX—IX

MADRAS OBSERVATORY—Number of miles of wind from each point in the year 1914.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January .. .. | 62 | 94 | 290 | 2039 | 1232 | 806 | 190 | 129 | 28 | 7 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4877 |
| February ... ... | ... | ... | ... | 19 | 79 | 203 | 192 | 511 | 197 | 260 | 115 | 37 | 354 | 754 | 92 | 187 | 52 | 54 | 17 | 7 | 4 | 4 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3138 |
| March .. | ... | ... | ... | ... | ... | ... | ... | 150 | 224 | 206 | 290 | 665 | 414 | 1575 | 496 | 123 | 78 | 99 | 86 | 66 | 9 | 10 | 9 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4500 |
| April ... ... ... | ... | 10 | ... | 10 | 7 | 16 | 9 | ... | 13 | 6 | 26 | 219 | 1131 | 2110 | 772 | 124 | 155 | 177 | 158 | 28 | ... | ... | ... | ... | ... | ... | 8 | ... | ... | ... | 8 | 41 | 5028 |
| May ... ... | 5 | 18 | 10 | ... | | 16 | 13 | ... | 29 | 78 | 204 | 186 | 466 | 668 | 1254 | 687 | 381 | 459 | 328 | 338 | 212 | 160 | 205 | 84 | 84 | 80 | 70 | 43 | 17 | 5 | ... | 8 | 6108 |
| June ... ... ... | 27 | 9 | 31 | 5 | 7 | ... | ... | 21 | 60 | 115 | 108 | 163 | 252 | 659 | 408 | 408 | 335 | 174 | 60 | 301 | 267 | 210 | 428 | 400 | 373 | 518 | 232 | 201 | 64 | 22 | 14 | 9 | 5881 |
| July .. ... ... | 2 | ... | ... | ... | ... | ... | ... | ... | ... | 23 | ... | ... | 42 | 197 | 238 | 100 | 66 | 139 | 161 | 342 | 480 | 546 | 411 | 950 | 775 | 364 | 242 | 74 | 75 | 31 | 5 | 25 | 5288 |
| August ... ... | ... | ... | ... | 9 | 8 | ... | 3 | ... | 15 | 80 | 28 | 70 | 71 | 44 | 253 | 173 | 123 | 146 | 243 | 321 | 243 | 188 | 199 | 662 | 546 | 483 | 188 | 135 | 63 | 28 | 2 | 18 | 4342 |
| September ... ... | 7 | 8 | 6 | 3 | ... | ... | ... | 7 | 9 | 56 | 44 | 84 | 258 | 329 | 531 | 370 | 170 | 170 | 333 | 279 | 310 | 281 | 79 | 183 | 134 | 168 | 134 | 42 | 57 | 18 | ... | ... | 4070 |
| October ... ... | 109 | 455 | 336 | 620 | 278 | 279 | 209 | 439 | 164 | 84 | 120 | 38 | 12 | 83 | 71 | 24 | 8 | 5 | 16 | 7 | ... | ... | 13 | ... | 4 | 19 | 7 | 12 | 15 | ... | ... | 44 | 3471 |
| November ... .. | 860 | 780 | 692 | 582 | 457 | 246 | 190 | 104 | 51 | 27 | 35 | 52 | 34 | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 10 | 201 | 4321 |
| December ... ... | 172 | 459 | 880 | 1600 | 746 | 549 | 28 | 31 | 16 | 7 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4 | 4 | ... | 11 | ... | 4 | 362 | 4873 |
| Annual total ... | 1244 | 1833 | 2245 | 4887 | 2814 | 2115 | 834 | 1392 | 806 | 949 | 970 | 1514 | 3034 | 6419 | 4115 | 2196 | 1368 | 1423 | 1402 | 1689 | 1525 | 1399 | 1344 | 2279 | 1916 | 1636 | 885 | 507 | 302 | 104 | 43 | 708 | 55897 |

# APPENDIX X.

MADRAS OBSERVATORY.—Number of inches of rain from each point in the year 1914.

| Month. | N | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January ... | 0·05 | ... | 0·13 | ... | 0·13 | 0·24 | 0·20 | 0·21 | 0·10 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| February ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| March ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| April ... | ... | 0·27 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·01 | 0·23 | ... | ... | 0·03 | ... | 0·04 | 0·65 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·01 | 0·81 | ... |
| May ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·01 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| June ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·10 | 0·02 | 0·01 | 0·03 | ... | | 0·04 | 0·02 | ... | 0·11 | ... | 0·24 | ... | ... | ... | ... | ... | 0·03 | 0·01 | 0·03 | ... | ... | ... | ... |
| July ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·04 | ... | ... | 0·01 | ... | ... | 0·20 | 0·25 | 0·23 | 0·21 | 0·29 | 0·15 | 0·07 | 0·02 | 0·09 | 0·43 | 0·23 | 0·36 | ... | ... | 0·02 |
| August ... | ... | ... | ... | ... | ... | ... | 0·06 | ... | ... | ... | 0·13 | ... | ... | 0·51 | ... | 0·03 | ... | 0·48 | 0·13 | 0·87 | 0·47 | 0·02 | 0·62 | 0·84 | 1·77 | 2·65 | 0·05 | 0·04 | 0·25 | ... | ... | 0·48 | 0·01 |
| September.. | ... | ... | ... | 0·38 | ... | ... | ... | ... | ... | ... | ... | 0·72 | 0·92 | 0·01 | ... | 0·04 | 0·67 | 1·14 | 0·70 | 0·93 | 0·64 | 0·02 | 0·08 | 0·02 | 0·17 | 0·05 | 0·15 | ... | 0·20 | ... | ... | ... | ... |
| October ... | 0·02 | 1·00 | 0·46 | 1·51 | 2·09 | 1·79 | 3·09 | 2·74 | 1·56 | 1·21 | 1·95 | 1·09 | . | ... | 0·01 | ... | ... | 0·49 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·21 |
| November ... | 0·90 | 1·93 | 1·46 | 0·23 | 1·34 | 1·07 | 0·62 | 0·62 | 0·50 | 1·51 | 0·02 | 0·08 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·24 | 3·31 | 0·20 |
| December ... | 0·02 | ... | 0·34 | 0·01 | ... | 0·35 | ... | ... | ... | 0·05 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Annual .. | 0·99 | 3·20 | 2·39 | 2·13 | 3·56 | 3·45 | 3·97 | 3·57 | 2·16 | 2·87 | 2·12 | 1·90 | 1·00 | 0·75 | 0·01 | 0·12 | 0·72 | 2·11 | 1·18 | 2·70 | 1·58 | 0·25 | 0·99 | 1·02 | 2·01 | 2·72 | 0·32 | 0·48 | 0·71 | 0·36 | 0·25 | 4·60 | 0·44 |

# APPENDIX XI.

Madras Observatory—Wind, cloud and bright sunshine, 1914.

| Months. | Wind resultant. | | Clouds (0—10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H. | 16 H. | 20 H. | Mean. | Average per day. | Greatest number of hours in a day. |
| | MILES. | POINTS. | | | | | | HOURS. | HOURS. |
| January ... ... | 152 | N.E. | 3·0 | 3·2 | 3·4 | 1·9 | 2·9 | 7·2 | 9·3 |
| February ... ... | 87 | E.S.E. | 1·5 | 2·4 | 1·3 | 0·9 | 1·6 | 9·1 | 10·2 |
| March ... ... | 133 | S.E. | 1·9 | 2·1 | 0·6 | 0·5 | 1·3 | 8·4 | 10·2 |
| April ... ... | 153 | S.E. by S. | 4·4 | 3·7 | 1·6 | 1·5 | 2·8 | 9·0 | 10·9 |
| May ... ... | 144 | S. by E. | 3·7 | 3·3 | 4·2 | 4·0 | 3·9 | 6·4 | 9·6 |
| June ... ... | 102 | S.W. by S. | 4·6 | 4·2 | 5·9 | 4·3 | 4·9 | 4·9 | 7·9 |
| July ... ... | 130 | W.S.W. | 8·0 | 7·7 | 8·3 | 8·6 | 8·2 | 2·4 | 7·6 |
| August ... ... | 90 | S.W. by W. | 6·6 | 6·2 | 6·9 | 6·1 | 6·5 | 4·3 | 10·6 |
| September ... ... | 87 | S. by W. | 5·1 | 4·9 | 5·1 | 4·2 | 4·9 | 5·7 | 10·7 |
| October ... ... | 85 | N.E. | 5·7 | 6·3 | 7·8 | 6·0 | 6·5 | 4·1 | 9·3 |
| November ... ... | 127 | N.N.E. | 5·2 | 5·7 | 6·1 | 4·4 | 5·4 | 5·3 | 9·0 |
| December ... ... | 145 | N.E. by N. | 4·0 | 4·8 | 4·7 | 3·3 | 4·2 | 5·8 | 8·6 |
| Annual ... | 33 | S.E. | 4·5 | 4·5 | 4·7 | 3·8 | 4·4 | 6·1 | ... |

# APPENDIX XII.

## MEAN Monthly and Annual Meteorological Results at the Madras Observatory in 1914.

| | Barometer. Reduced to 32°. | Barometer. Daily Range. | Dry Bulb Thermometer. Mean. | Dry Bulb Thermometer. Max. | Dry Bulb Thermometer. Min. | Dry Bulb Thermometer. Range. | Wet Bulb. Mean. | Wet Bulb. Min. | Tension of Vapour. By Blanford's Tables. | Relative Humidity. By Blanford's Tables. | Sun Max in Vac. | Min. on Grass. | Wind. Daily Velocity. | Wind. Points. | Wind. Mean Direction. | Rain. Amount. | Rain. Days. | Cloudy Sky. | Bright Sun-shine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | Miles. | Points. | | INCHES. | No. | CENTS. | HOURS. |
| January ... ... | 30·069 | 0·102 | 75·7 | 83·6 | 67·9 | 15·7 | 69·6 | 66·3 | 0·641 | 72 | 148·3 | 64·0 | 157 | 4 | N. E. | **1·06** | 2 | 29 | 224·3 |
| February ... .. | 29·987 | ·124 | 77·4 | 86 5 | 68·6 | 17·9 | 71·5 | 67·6 | ·693 | 74 | 149·9 | 65·5 | 112 | 10 | E. S. E. | ... | . | 16 | 256·1 |
| March ... ... | ·913 | ·133 | 81·8 | 90·4 | 73·9 | 16·5 | 75·7 | 72·8 | ·805 | 74 | 153·2 | 71·6 | 145 | 12 | S. E | ... | ... | 13 | 261·2 |
| April ... ... | ·871 | ·129 | 83·3 | 96·8 | 76·8 | 14·0 | 78·7 | 75 9 | ·903 | 79 | 152·3 | 75·2 | 167 | 13 | S. E. by S. | 2·05 | 4 | 28 | 270 4 |
| May . ... | ·743 | ·121 | 88·4 | 100·5 | 82·0 | 18·5 | 79·9 | 77·5 | ·904 | 68 | 152 1 | 80·9 | 197 | 15 | S. by E. | 0·01 | 1 | 39 | 197·1 |
| June ... ... | ·692 | ·123 | 88·4 | 101·7 | 82·3 | 19·4 | 77·8 | 74·7 | ·805 | 61 | 150·2 | 81·2 | 196 | 18 | S. S. W. | 0·64 | 8 | 49 | 148·3 |
| July ... ... | ·679 | ·124 | 85·7 | 96·6 | 79·6 | 17·0 | 77·0 | 74·1 | ·810 | 66 | 139·7 | 78·4 | 171 | 22 | W. S. W. | 2·60 | 19 | 82 | 74·5 |
| August ... .. | ·746 | ·114 | 83·4 | 93·2 | 77·2 | 16·0 | 77·2 | 74·2 | ·854 | 75 | 145·3 | 76·0 | 140 | 21 | S. W. by W. | 9·41 | 16 | 65 | 134·8 |
| September ... ... | ·792 | ·132 | 82·9 | 91 8 | 76·6 | 15·2 | 78·3 | 74·8 | ·902 | 81 | 149·4 | 75·1 | 136 | 17 | S. by W. | 6·84 | 11 | 49 | 173·4 |
| October ... .. | ·922 | ·107 | 80·4 | 87·5 | 75·1 | 12·4 | 76 7 | 74·1 | ·867 | 84 | 146 6 | 73·6 | 112 | 5 | N. E. by E. | 19·22 | 18 | 65 | 126·9 |
| November ... .. | ·909 | ·107 | 78·4 | 85·2 | 73·0 | 12·2 | 74·5 | 71·7 | ·802 | 82 | 142·7 | 70 7 | 144 | 3 | N. E. by N. | 14·03 | 12 | 54 | 159·7 |
| December ... ... | 962 | ·108 | 77·1 | 85·2 | 70 8 | 14·4 | 71·8 | 69·1 | ·711 | 76 | 147·3 | 68·4 | 157 | 3 | N. E. by N. | 0·77 | 4 | 42 | 180·3 |
| Annual ... | 29·857 | 0·119 | 81·9 | 91·1 | 75·3 | 15·8 | 75·7 | 72·7 | 0·808 | 74 | 148·1 | 73·4 | 153 | 12 | S. E. | 56·63 | 95 | 44 | 2,207·0 |

## EXTREME Monthly Meteorological Records at the Madras Observatory in 1914.

| | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry Bulb Thermometer. Highest. | | Dry Bulb Thermometer. Lowest. | | Wet Bulb. Lowest. | | Humidity. Lowest. | | Sun Th. in Vacuo. Highest. | | Grass Therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest Fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY. |
| January ... | **30·216** | **9** | 9·923 | 21 | 0·293 | 84·8 | 29 | 63·4 | 27 | 61·9 | 27 | 49 | 27, 29 | 151·5 | 30 | 59·4 | 27 | 231 | 9 | 113 | 31 | 0·57 | 1 |
| February ... | ·113 | 12 | ·836 | 17 | 277 | 89·3 | 6 | 63·2 | 25 | 62·4 | 25 | 33 | 5 | 154·2 | 23 | 59·1 | 5 | 192 | 18 | 58 | 2 | .. | ... |
| March ... | ·115 | 19 | ·753 | 31 | 362 | 96·1 | 11 | 68·3 | 4 | 67·7 | 3, 4 | 49 | 29 | 157·6 | 22 | 65·8 | 4 | 200 | 21 | 81 | 28 | ... | ... |
| April ... | ·026 | 10 | ·682 | 30 | ·344 | 95·8 | 1 | 71·6 | 2 | 71·6 | 2 | 53 | 19 | 163·7 | 14 | 70·5 | 25 | 234 | 30 | 87 | 2 | 0·95 | 2 |
| May ... | 29·938 | 3 | ·556 | 31 | ·382 | 108·9 | 31 | 78·2 | 6 | 73·3 | 18 | 25 | 31 | 159·2 | 7 | 77·2 | 2 | 280 | 28 | 102 | 14 | 0·01 | 5 |
| June ... | ·819 | 6 | **·511** | **25** | ·308 | **110·3** | **1** | 76 0 | 14 | 71·9 | 3 | **22** | **2** | 165·6 | 1 | 74·2 | 14 | 277 | 2 | 139 | 13 | 0·21 | 4 |
| July ... | ·828 | 16 | ·532 | 10 | ·296 | 104·1 | 1, 6 | 75·6 | 15 | 72·5 | 25 | 35 | 10, 11 | 157·4 | 12 | 73·9 | 15 | 245 | 12 | 80 | 23 | 0·51 | 17 |
| August ... | ·920 | 9 | ·547 | 17 | ·373 | 100·0 | 1 | 73·8 | 11 | 72·1 | 4 | 46 | 3 | 157·6 | 26 | 72·5 | 11 | 180 | 1 | 92 | 5 | 2·89 | 17 |
| September ... | ·995 | 19 | ·577 | 13 | ·418 | 98·0 | 2 | 72·1 | 22 | 71·0 | 8 | 47 | 5 | 162·4 | 2 | 71·1 | 22 | 197 | 27 | 54 | 19 | 2·08 | 10 |
| October ... | 30·068 | 25 | ·722 | 6 | ·346 | 97·3 | 6 | 72·3 | 29 | 71·7 | 29 | 53 | 3, 4, 5 | **168·6** | **5** | 71·7 | 17 | 240 | 31 | 62 | 10 | 3·49 | 22 |
| November ... | ·054 | 27 | 770 | 1 | ·284 | 87·3 | 9 | 65·2 | 23 | 63·8 | 23 | 40 | 22 | 155·6 | 20 | 61 3 | 23 | 289 | 1 | **45** | **7** | **7·46** | **1** |
| December ... | ·133 | 28 | ·729 | 20 | **·404** | 89·7 | 21 | **60·6** | **24** | **60·2** | **24** | 33 | 22 | 154·5 | 14 | **56·9** | **24** | **304** | **3** | 75 | 12 | 0·36 | 1 |

# ANNUAL REPORT

OF THE

# DIRECTOR
# KODAIKANAL AND MADRAS OBSERVATORIES

FOR 1915.

MADRAS:
PRINTED BY THE SUPERINTENDENT, GOVERNMENT PRESS.

1916.

# KODAIKANAL AND MADRAS OBSERVATORIES.

## REPORT FOR THE YEAR 1915.

CONTENTS.

### I.—KODAIKANAL OBSERVATORY.



### II.—MADRAS OBSERVATORY.

# KODAIKANAL AND MADRAS OBSERVATORIES.

## I.—REPORT OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1915.

*Staff.*—The staff of the observatory on December 31, 1915, was as follows:—

| | |
|---|---|
| Director ... ... ... ... ... | J. Evershed, F.R.S. |
| Assistant Director ... ... ... ... | T. Royds, D.Sc. |
| First Assistant ... ... ... ... | S. Sitarama Ayyar, B.A. |
| Second Assistant ... ... ... ... | G. Nagaraja Ayyar. |
| Third Assistant ... ... ... ... | A. A. Narayana Ayyar, B.A. |
| Fourth Assistant ... ... ... ... | S. Balasundaram Ayyar. |
| Writer ... ... ... ... ... | L. N. Krishnaswami Ayyar. |
| Photographic Assistant ... ... ... | R. Krishna Ayyar. |

The Director-General of Observatories, Dr. Gilbert T. Walker, represented to Government the desirability of a second expedition to Kashmir with a larger and more complete instrumental equipment than had been taken in 1914. His efforts and the representations made by Professor H. H. Turner of Oxford University Observatory resulted in sanction being accorded to the proposal, and a sum of Rs. 5,600 was granted to defray expenses.

The Director accompanied by the First Assistant and the Photographic Assistant left Kodaikanal on July 6 for Kashmir and arrived at Srinagar on July 15. A preliminary account of the work of the expedition up to the end of the year is given in section 10.

The Assistant Director returned from combined leave on May 30.

The subordinate staff consists of a book-binder, an assistant book-binder, a mechanic, five peons, a boy peon for the dark room and two lascars.

2. *Distribution of work.*—Until the departure of the Kashmir Expedition the distribution of work was as follows. The Director and the Assistant Director had charge of the two spectroheliographs and the large grating spectrograph. The First, Second and Third Assistants were in charge of the work with the Cooke equatorial (spectroscopic), the Lerebour and Secretan equatorial (visual and photographic) and the transit instrument. They had also to do the astronomical computing, the preparation of the observations for the press and the measurement of spectrum plates. The Third Assistant had charge of the seismometer and clock comparisons. The meteorological work was done by the Fourth Assistant and the Writer. The Fourth Assistant also assisted in the preparation of observations for the press. The Writer was responsible for the accounts, correspondence and all office records. The Photographic Assistant had charge of the photographic developing, printing, etc.

When the Kashmir Expedition left in July the work had to be redistributed among the assistants remaining in Kodaikanal. The Assistant Director took charge of the spectroheliograph and the large grating spectrograph. The Second and Third Assistants had the First Assistant's duties divided between them. The visual and photographic work with the Lerebour and Secretan equatorial was discontinued for the duration of the Kashmir Expedition. The Fourth Assistant took a portion of the Photographic Assistant's work being relieved by the Writer of some of his meteorological duties. The staff at Kodaikanal have undertaken these extra duties with commendable loyalty.

3. *Buildings and grounds.*—The buildings and grounds and fire lines have been kept in good order. A small grass fire originating within the grounds occurred on December 23, but no damage was done except one pine tree burnt.

Estimates for reroofing the spectroheliograph building and the glazed verandah are in preparation.

4. *Instruments.*—The following are the principal instruments belonging to the observatory, or in use, at the present time :—

Six-inch Cooke equatorial.

Six-inch Lerebour and Secretan equatorial remounted by Grubb, with a five-inch Grubb portrait lens attached. The Lerebour and Secretan object glass has been replaced by a Cooke photo-visual lens of the same aperture and the instrument has been adapted for direct solar photography in addition to visual work.

Spectrograph I.—This with the 11-inch polar siderostat has been dismounted and a new spectrograph fed by the 12-inch Foucault siderostat from Poona is under construction.

Spectrograph II—consisting of a collimator of 7 feet focus and camera of 14 feet focus placed at an angle of 60° with the former. Plane gratings of $3\frac{1}{4}$ inches or 5 inches ruled surface are used, and the slit is provided with various devices for the direct comparison of spectra from different sources, and for rotating the solar image.

Spectroheliograph—with 18-inch siderostat and 12-inch Cooke photo-visual lens of 20 feet focus, by the Cambridge Scientific Instrument Company.

An auxiliary spectroheliograph attached to the above, made in the Observatory workshop.

Six-inch transit instrument and barrel chronograph, formerly the property of the Survey of India.

Theodolite, 6-inch—Cooke.

Sextant.

Evershed spectroscope with three prisms, for prominence and sunspot work, by Hilger.

Mean time clock, Kullberg 6326.

Do. Shelton.

Mean time chronometer, Kullberg 6299.

Sidereal chronometer, Kullberg 6134.

Tape chronograph, Fuess.

Two micrometers for measuring spectrum photographs, Hilger.

Hartmann photometer.

Dividing engine, Cambridge Scientific Instrument Company, Limited.

Milne horizontal pendulum seismograph.

Induction coil with necessary adjuncts.

Small polar siderostat.

Universal instrument.

Complete set of meteorological instruments, including a Richard thermograph and barograph and a nephoscope.

A high class screw cutting turning lathe, by Messrs. Cooke & Sons.

Angström pyrheliometer.

An 18-inch concave mirror by Henry of Paris belonging to the Director is mounted in the spectroheliograph room for general spectrum work.

The instruments received from the Takhtasinghji Observatory at Poona include the following :—

Twenty-inch reflecting telescope, by Common.

Six-inch Cooke photo-visual telescope with equatorial mounting.

Two prisms of 6 inches aperture for use with the above.

Twelve-inch Cooke siderostat.

Eight-inch horizontal telescope.

Large grating spectroscope, by Hilger.

An ultra-violet spectrograph, by Grubb.

Sidereal clock, Cooke.

Mean time chronometer, Frodsham No. 3476.

One micrometer for measuring spectrum photographs, Hilger.

The Observatory is greatly indebted to His Highness the Nizam's Government and to the Director of the Nizamiah Observatory for the loan of the following lenses received in January :—

A 15-inch lens, a 12-inch lens, a 7-inch lens, all by Grubb, and a 4-inch photovisual lens, by Cooke.

A large spectroheliograph for photographing solar images up to $4\frac{1}{2}$ inches diameter was partly constructed in the Observatory workshop and afterwards erected and completed at Srinagar, Kashmir.

## OBSERVATIONS.

### (*a*) Solar Physics.

5. The following table gives the number of observations made at Kodaikanal during each month of the year :—

| — | January. | February. | March. | April. | May. | June | July. | August. | September. | October. | November. | December. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 30 | 28 | 31 | 30 | 31 | 25 | 22 | 30 | 29 | 31 | 28 | 23 | 338 |
| B | 4 | 11 | 8 | 4 | 3 | 1 | 4 | 0 | 0 | 2 | 0 | 0 | 37 |
| C | 29 | 25 | 31 | 30 | 31 | 19 | 14 | 21 | 19 | 26 | 18 | 21 | 284 |
| D | 29 | 28 | 31 | 27 | 30 | 18 | ... | ... | ... | ... | ... | .. | 163 |
| E | 30 | 28 | 31 | 30 | 31 | 26 | 20 | 26 | 25 | 30 | 25 | 23 | 325 |

A = disc examined. B = spot spectrum observed. C = prominences photographed. D = photoheliograms taken. E = spectroheliograms taken.

Although more observations than in normal years were made in October, the year on the whole was not more favourable than previous years.

6. *Photoheliograph.*—Photographs were obtained at Kodaikanal on 163 days up to June 19. The photoheliograph was dismounted on that date, the photo-visual object glass and other optical parts being required for work in Kashmir.

7. *Spectroheliograph.*—Monochromatic photographs of the sun's disc in "K" light were taken on 325 days and prominence plates on 284 days. The autocollimating spectroheliograph was in use with the Michelson grating throughout the year and photographs of H$\alpha$ markings were obtained on 208 days.

Duplicates of the disc photographs in "K" light have been sent to the Cambridge Observatory for measurement.

8. *Grating Spectrograph.*—An exceptionally fine series of spot spectra was obtained, using the new Anderson grating. In these the exposure times were reduced to from two to fifteen seconds only, and the limits of the penumbrae and other details are well shown. New and interesting features in the radial motion displacement are shown, and some of the plates give evidence of motion at right angles to the radial movement, perhaps indicating rotation of the spot.

A series of fourth order solar spectra in the H and K region was secured for study of the change of wave-length of certain iron lines between the centre of the disc and the limb. A beautiful series of third order spectra in the green region, of limbs and centre of the disc, was secured for study of limb shifts and solar rotation shifts. A series of spectra of general sunlight with iron arc comparison was also photographed for the purpose of comparing the shifts obtained with those observed at the centre of the sun's disc. This last is of importance in connection with a proposed research of the wave-lengths of the solar lines reflected from Venus when the planet receives light from a hemisphere of the sun turned 90° or more from the earth. If the general shift of the solar lines all over the disc is due to a movement of recession from the earth, this shift would not be observed in the Venus spectrum, after allowing for the effect of the orbital motion of the planet, and there would be a difference of wave-length in the lines of ordinary day light and light derived from another face of the sun. If this difference does not exist, the shift of the solar lines towards red must be ascribed to some cause other than motion in the line of sight.

The measurement of the various series of spectra obtained has not been completed, owing to the pressure of work in connection with the Kashmir expedition, except in the case of the fourth order H and K spectra, and the investigation of the change of wave-length in passing from the centre of the sun's disc to the limb was being prepared for the press at the close of the year.

The spectrograph has also been employed by the Assistant Director who has determined the displacements at the centre of the sun's disc and at the limb of the lines of nickel and titanium; the results of this work will shortly be ready for the press. He has also continued experiments with the electric arc to elucidate the density effect: the result of these is to show that the displacements observed are not a pole effect, but that a source of light where the density is under better control than in the arc is necessary for the effective study of the phenomenon.

9. 6-*inch Cooke equatorial and spectroscope*.—This has been employed exclusively for spectrum observations, attention being concentrated on phenomena which cannot readily be photographed, such as metallic prominences, temporary eruptions, and displacements of the hydrogen lines both on the sun's disc and at the limb. The position angles of a few definitely marked prominences are also determined for the purpose of checking the correctness of the angles measured on the photographs; these depend on a fundamental angle computed from the hour angle of the sun at the time a photograph is taken, and errors which would otherwise pass unnoticed may arise in the computation or in the entry of the time.

10. *Observations in Kashmir*.—The months of July, August and September were mainly occupied in erecting and adjusting the large spectroheliograph, the siderostat, and moving object-glasses. In addition a 6-inch Cooke equatorial telescope was erected, and a small grating spectroscope was constructed for attachment to the equatorial for the observation of prominences. The adjustment of the equatorial was completed, and spectroscopic observations were begun, on August 8. The spectroheliograph was practically completed early in September, the first photograph being taken on September 9. From this date until the end of the year, H or K spectroheliograms were taken on all clear days, viz., on 20 days in September, 26 days in October, 29 days in November, and 18 days in December. The photographs in December were interrupted for many days by smoke from extensive forest fires, induced by the excessive drought.

The weather throughout the summer and the early autumn had been exceedingly dry: October had less than half the normal rainfall, and November and December were rainless, excepting a light fall of snow on December 15. These conditions are very abnormal in the valley, and resulted in great desiccation of the soil, grass and other vegetation being completely withered up. This parched condition of the valley and the surrounding hills, and the great heat developed by the sun on the ground, appear to have affected the seeing unfavourably. The quality of the solar definition was however good during July, August and September; in October and November the increasing dryness and the decreasing altitude of the sun had a marked effect detrimental to the quality of the spectroheliograms. It may be noted that in the earlier months the best results were obtained in the afternoon, which agrees with our experience during the spring expedition of 1914; later, in November and December, the best photographs were obtained early in the day.

On the whole, the results are less good than had been anticipated from the previous experience. It is however of interest to learn that abundant moisture in the valley is a most important factor in producing good solar definition.

The visual observations of the prominences bear out in general the conclusions derived from the spectroheliograms. During the three months August-September-October, the conditions for this work were almost ideal: there was excellent contrast in the H$\alpha$ line, due to the purity of the sky, and the definition was good at all hours of the day. During November the conditions were somewhat less good, although still superior to the average at Kodaikanal. In December there was much cloud, and the seeing was generally less good than in November. The first assistant, S. Sitarama Ayyar, had charge of these observations, and he was able to secure a very complete set of prominence drawings. In the four months August 8 to December 13 only four days were missed, owing to cloud; after December 13 observations were interrupted by a snow-storm and thick clouds, yet the record for December, owing to his zeal, is 20 days' observation. Sitarama Ayyar's work has been incorporated with the Kodaikanal prominence observations for the half-year ending December 31.

Independent observations of the definition of an 8-inch solar image were made daily by Mrs. Evershed, from the date of arrival at Srinagar. Her report shows a general mean of $3\frac{1}{4}$ on a scale in which 5 represents no appreciable tremor in the 8-inch image. The definition during the first half of the period shows slightly better (3·4), and the last half slightly worse (3·1) than the mean. Also in the earlier months the midday and afternoon seeing was slightly better than the morning, but later the earlier hours were best. The uniformity of the seeing is the most remarkable feature: it was very rarely of the best quality, and never of the worst, and there was but little change at different hours of the day.

It should be mentioned that in the photographic work Mr. Krishna Ayyar rendered excellent service throughout. In the long series of difficulties and disappointments incidental to the initial working of the spectroheliograph, Krishna Ayyar maintained a cheerful optimism. Only those who have had experience of this instrument can appreciate the disheartening nature of these difficulties.

*Summary of Sunspot and Prominence Observations.*

11. *Sunspots.*—The following table shows the monthly numbers of new groups observed at Kodaikanal, the mean daily numbers of spots visible and the distribution between the northern and southern hemispheres :—

| — | January. | February. | March | April. | May | June. | July. | August. | September. | October. | November. | December. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups ... ... | 18 | 18 | 18 | 18 | 14 | 18 | 14 | 17 | 12 | 17 | 19 | 15 | 198 |
| Daily number ... ... | 2·4 | 3·3 | 3·7 | 3·1 | 3·2 | 3·0 | 3·5 | 3·1 | 3·0 | 3·2 | 3·2 | 3·1 | 3·2 |
| North ... ... ... | 15 | 10 | 12 | 7 | 10 | 8 | 6 | 10 | 5 | 13 | 12 | 6 | 114 |
| South ... ... ... | 3 | 8 | 6 | 11 | 4 | 10 | 8 | 7 | 7 | 4 | 7 | 9 | 84 |
| Equator ... ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

There is again a marked increase in spot activity compared with last year in accordance with the usual progress of a new spot cycle. The daily number of spots in each month has been fairly constant since January.

For the first time since 1906 there has been a preponderance of spots in the northern hemisphere.

12. *Prominences.*—The increase in solar activity during 1915 is more marked in prominence areas than in sunspots. The mean areas obtained from the photographs for 1915 and those of 1914 for comparison are given in the table below :—

*Mean daily Profile areas of Prominences in square minutes of arc.*

| — | 1914. | 1915. |
|---|---|---|
| North ... ... ... | 1·50 | 2·60 |
| South ... ... .. | 1·60 | 2·68 |
| Total ... | 3·10 | 5·28 |

There is only a slight preponderance in the southern hemisphere. The zone of greatest activity is again between latitudes 45° and 60°.

Metallic prominences have also been more frequently observed than in 1914; forty-five were recorded as against seventeen last year.

There has also been an increase, on the whole, in the number of displacements in prominences at the limb though fewer than would have been expected were seen in the second half of the year.

13. *Solar Radiation.*—Observations with the Ångström pyrheliometer were made near noon when the meteorological conditions were favourable.

## (b) Other observations.

14. *Time.*—The error of the standard clock is usually determined by reference to the 16-hour signal from the Madras Observatory. This is rendered possible by the courtesy of the Telegraph Department which permits the Madras wire to be joined through to this observatory. The signal is received with accuracy on most days and all failures are at once reported to the officer in charge of the Trichinopoly division.

15. *Meteorology.*—Eye observations are made at $8^h$, $10^h$, and $16^h$ local mean time as in former years. The Richard thermograph (wet and dry bulb) and barograph, the Beckley anemograph and the sunshine recorder also continue in use. The hourly readings from the barograms, thermograms, and sunshine records are now tabulated at the Calcutta Meteorological Office and the anemograms at the Madras Observatory which also prepares the $8^h$ registers from readings taken here. The preparation of the $10^h$ and $16^h$ registers is done in the Calcutta Meteorological Office. The wind velocity and direction are observed at $8^h$, $10^h$ and $16^h$ as usual from the Robinson anemometer and a wind vane.

Cloud observations with the nephoscope have been made three times a day and the results transmitted monthly to the Agra Aerological Observatory.

*Pressure.*—The average pressure for the year was in excess of the normal by 0·012 inch. The mean monthly pressure was in excess in all the months except in September, October, and November. The greatest excess was in March by 0·049 inch and the greatest defect was in November by 0·020 inch.

*Temperature.*—The monthly mean temperature as well as the mean maximum was above normal in all the months. The annual mean temperature was in excess by 3°·0 and the annual mean maximum by 2°·0. The monthly mean minimum temperature was also in excess in all the months except in April and in December. The greatest deviation was an excess of 2°·8 over normal in November. The mean sun maximum was in excess throughout the year.

*Humidity.*—The annual mean humidity was in defect of the normal by only one per cent. The greatest deviations were an excess of 6 per cent in November and a defect of 10 per cent in May.

*Rainfall.*—The total rainfall for the year was 5·85 inches below normal and the number of rainy days was less by six. The month of October which normally has the heaviest rainfall was in defect by 6·36 inches, owing to the lateness of the North-East Monsoon.

*Wind.*—The wind velocity was in defect throughout the year and the average daily velocity was less than the normal by 53 miles. The mean wind direction for the year differed from the normal by two points to the west, mostly due to the south by west wind prevailing in October.

*Transparency of the atmosphere.*—The transparency of the lower atmosphere as judged by the visibility of the Nilgiris, about 100 miles distant was greater than either in 1913 or 1914. There were 129 days when the Nilgiris were visible as against 93 days in 1913 and 95 days in 1914.

*Cloud and Sunshine.*—The mean amount of clear sky was only one per cent less than normal; but curiously there was an excess of 374 hours, or 18 per cent of bright sunshine.

16. *Seismology.*—Seventy-two earthquakes were recorded on the Milne horizontal pendulum, as against sixty last year. Details of the records are given in Appendix I.

17. *Library.*—One hundred and thirty volumes were bound during the year.

18. *Publications.*—Four Bulletins, with the following titles were published during the year :—

No. XLV.—Summary of prominence observations for the second half of 1914, by J. Evershed, F.R.S.

No. XLVI.—The displacements of the enhanced lines of iron at the Centre of the Sun's Disc, by J. Evershed, F.R.S., and A. A. Narayana Ayyar, B.A.

No. XLVII.—Summary of prominence observations for the first half of 1915, by T. Royds, D.Sc.

XLVIII.—Anomalous dispersion in the Sun, by T. Royds, D.Sc.

The following contribution was made in addition to the above :—

"Note on the atmospheric conditions required for astronomical observations," by J. Evershed, F.R.S. Publications of the Astronomical Society of the Pacific, Volume 27, page 179, 1915.

19. *General.*—The Director-General of Observatories inspected the Kodaikanal Observatory in January.

THE OBSERVATORY, KODAIKANAL,
*28th January 1916.*

J. EVERSHED,
*Director, Kodaikanal and Madras Observatories.*

## II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1915.

*Staff.*—The staff at the Observatory on December 31, 1915, was as follows :—

| | |
|---|---|
| Deputy Director .. ... ... ... | R. Ll. Jones. |
| Computer ... ... ... ... ... | S. Solomon Pillai. |
| First Assistant ... ... ... ... ... | C. Chengalvaraya Mudaliyar. |
| Second Assistant ... ... ... ... | E. Ramanujam Pillai. |

Mr. C. Chengalvaraya Mudaliyar was absent on privilege leave for two months from 8th June 1915, when Mr. V. Duraiswami Ayyar of the Meteorological Office acted for him. Mr. E. Ramanujam Pillai was absent on privilege leave for two months from 1st September 1915, when Mr. P. R. Chidambaram Ayyar of the Meteorological Office acted for him.

2. *Time Service.*—No change was made during the year. The time gun at Fort St. George failed on 22 occasions out of 730, giving a percentage of success of 97. The semaphore at the Port Office failed on five occasions. On two of these days it was correctly dropped at 2 P.M. It was dropped correctly at 1 P.M. on all other days. None of the failures were due to faults at the Observatory. The 4 P.M. roll of signals was sent and received at the Central Telegraph Office, for distribution over India, correctly on every day.

3. *Meteorological Observations.*—Meteorological observations were carried on as in former years, and the registers are kept posted up to date. Extra observations were taken for storm warning purposes and telegrams sent to Calcutta on 70 occasions.

4. *Buildings.*—Repairs to the office and quarters were carried out during the year. The construction of the subsoil drain round the observatory sanctioned in the previous year was commenced towards the end of the year and is nearing completion. The construction was undertaken too late in the year for us to see if it will be effective in stopping the large variations in level which have been referred to in previous reports.

5. *Instruments.*—The following is a list of the instruments at the Observatory on 31st December 1915 :—

(a) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton & Simms.
Sidereal clock—Haswall.
Do. Dent, No. 1408.
Do. S. Riefler, No. 61.
Mean Time clock—J. H. Agar Baugh, No. 105.
Do. with galvanometer—Shepherd & Sons.
Meridian circle—Troughton & Simms.
Portable transit instrument—Dolland.
Portable telescope with stand.
Tape chronograph—R. Fuess.
Relay for use with the Chronograph—Siemens.

(b) *Meteorological.*

Richard's Barograph—No. 10, L. Casella.
Do. Thermograph—No. 29637, L. Casella.
Beckley's Anemograph—Adie.
Sunshine Recorder—No. 149, L. Casella.
Nephoscope—Mons Jules Daboseq & Ph. Pellin.
Barometer, Fortin's—No. 1771, L. Casella.
Do. do. No. 725, L. Casella (spare).
Do. do. No. 1420, L. Casella (spare).

Dry bulb thermometer—No. 94221, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Wet do. No. 94219, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Dry Maximum thermometer—No. 8581, Negretti and Zambra.
Dry Minimum thermometer—No. 69017, L. Casella.
Wet do. No. 91753, Negretti and Zambra.
Sun Maximum thermometer—No. 127618, Negretti and Zambra.
Grass Minimum thermometer—No. 3377, Negretti and Zambra.
Rain-gauge (8″ diameter) -No. 1042, Negretti and Zambra.
Measure glass for above.
Rain-gauge (5″ diameter).
Measure glass for above.
Stop watch—No. A-3.

The cord of the Mean Time Clock by Agar Baugh was renewed and Chronometer by V. Kullberg No. 5394 was cleaned. The gun-firing apparatus at the Fort was repaired during the year.

The level of the transit instrument went through a series of large changes very similar to those observed in the previous five years. The recovery during the rains was not complete, so that some permanent alteration in level is left at the end of the year.

6. *Weather Summary.*—The following is a summary of the meteorological conditions at Madras during 1915 :—

*Pressure.*—Except in January, March, July and December when there was an excess, pressure was below normal throughout the year ; the greatest excess was 0·052 inch in March and the greatest defect was 0·073 inch in November. The highest pressure recorded was 30·140 inches on January 18 and the lowest 29·498 inches on May 9.

*Temperature.*—The mean temperature of the air was above normal throughout the year. The maximum temperature in shade was normal in June, below normal in January, July and September, and above in the other months. The minimum in the shade and solar heat in *vacuo* were above normal throughout the year. The highest shade temperature recorded was 107°·3 F. on May 12, 20, 21 and 23, and the lowest 63°·8 F. on December 5. The highest sun maximum was 165°·7 F. on August 23 and the lowest on grass was 60°·5 F. on December 5.

*Humidity.*—The percentage of humidity was normal in October, below normal in May and December and above in the remaining months.

*Wind.*—The wind velocity was in defect in all other months except in January, when it was almost normal. This is largely due to change of exposure as explained in previous reports. The highest velocity was 314 miles on November 21. The wind direction was normal or nearly normal in all months except in June, September, October and November, the most noticeable deviation being 8 points south in October owing to the late arrival of the North-East Monsoon.

*Cloud.*—The percentage of cloud was normal in November, above normal in January and February, and below in the remaining months.

*Sunshine.*—Except in January, February and November when there was defect, the percentage of bright sunshine was in excess over the normal throughout the year. The total number of hours of sunshine during the year was 2444·9.

*Rainfall.*—The rainfall in the year was above normal in January, July, September and November, nearly normal from February to April and below normal during the other months. The greatest excess was 8·72 inches in January and the greatest defect 8·36 inches in October. The total fall for the year was 56·61 inches on 92 days against an average of 49·02 inches. The most noticeable rainfall was 9·61 inches in January. Most of this rain fell during the 14th and 15th of the month and was due to a depression which formed in the south-west of the Bay during the 13th and 14th. This fall of 9·61 inches is the highest ever recorded in January at Madras since 1813. The monsoon rainfall from October 15 to the end of the year was 21·60 inches against an average of 26·00 inches. The greatest fall on any day was 6·69 inches on January 15.

THE OBSERVATORY, MADRAS,
22nd *January* 1916.

R. LL. JONES,
*Deputy Director.*

# APPENDIX I.

## STATION—KODAIKANAL OBSERVATORY.

### SEISMIC RECORDS.

$\phi = 10° 13' 50''$  $\lambda = 77° 28' 00''$  $h = 2\,343$ metres.  *Subsoil*—Rock.

*Apparatus*—Milne's Horizontal Pendulum Seismograph.

| 1915. | | | $T_o$ | $\frac{r}{T_o^2}$ | 1915. | | | $T_o$ | $\frac{r}{T_o^2}$ |
|---|---|---|---|---|---|---|---|---|---|
| January | ... | ... | 15·6 | 3·4 | July | ... | ... | 18·6 | 2·4 |
| February | ... | ... | 18·1 | 2·7 | August | ... | ... | 18·7 | 2·5 |
| March | ... | .. | 18·0 | 2·5 | September | ... | ... | 18·9 | 2·4 |
| April | ... | ... | 17·9 | 2·5 | October | ... | ... | 18·6 | 2·5 |
| May | ... | ... | 18·0 | 2·5 | November | ... | ... | 18·1 | 2·6 |
| June | ... | ... | 18·3 | 2·6 | December | ... | ... | 17·9 | 2·4 |

| No. | Date. | Phase. | Time G.M.T. | | | Period. (Sec.) | Amplitude ($u$). | | | Distance $\Delta$ (Km.) | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | An. | Ae. | Az. | | |
| | 1915. | | H. | M. | S. | | | | | | |
| 1 | January* 4 ... | eP | 0 | 07 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 0 | 13 | 24 | ... | ... | ... | ... | .. | |
| 2 | 4 ... | eP | 0 | 16 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 0 | 21 | 42 | ... | ... | ... | ... | ... | |
| 3 | 4 ... | eP | 0 | 30 | 30 | ... | ... | .. | ... | ... | Widening of line. |
| | | F | 0 | 34 | 42 | ... | ... | .. | ... | ... | |
| 4 | 5 ... | eP | 14 | 48 | 00 | ... | ... | ... | ... | ... | |
| | | eL | 14 | 55 | 36 | ... | ... | | ... | .. | |
| | | M | 15 | 04 | 54 | ... | ... | 50 | . | ... | |
| | | F | 15 | 56 | 24 | .. | .. | .. | ... | ... | |
| 5 | 5—6 ... | eP | 23 | 35 | 51 | ... | .. | .. | | | |
| | | iL | 23 | 41 | 18 | .. | ... | ... | ... | ... | |
| | | M | 0 | 00 | 18 | ... | ... | 100 | ... | ... | |
| | | F | 0 | 50 | 30 | ... | ... | ... | ... | ... | |
| 6 | 8 ... | eP | 9 | 56 | 42 | ... | . | ... | .. | ... | Widening of line. |
| | | F | 10 | 13 | 06 | .. | ... | ... | ... | ... | |
| 7 | 10 ... | eP | 1 | 09 | 12 | .. | .. | ... | ... | ... | Widening of line. |
| | | F | 1 | 15 | 42 | ... | ... | ... | | ... | |
| 8 | 11 ... | eP | 9 | 04 | 36 | ... | ... | .. | ... | .. | Widening of line. |
| | | F | 9 | 08 | 00 | | ... | ... | ... | ... | |
| 9 | 17 ... | eP | 4 | 01 | 48 | .. | ... | ... | ... | ... | Widening of line. |
| | | F | 4 | 04 | 54 | .. | .. | ... | .. | .. | |
| 10 | February 21 ... | eP | 5 | 45 | 48 | ... | ... | ... | ... | . | Widening of line. |
| | | F | 5 | 51 | 42 | . | ... | .. | ... | ... | |
| 11 | 21 ... | P | | ... | | | ... | ... | ... | ... | |
| | | iL | 15 | 07 | 06 | .. | - | ... | ... | ... | |
| | | M | 15 | 07 | 36 | ... | ... | 70 | ... | ... | |
| | | F | 15 | 27 | 12 | ... | .. | ... | ... | ... | |
| 12 | 25 ... | eP | 20 | 58 | 42 | ... | .. | ... | .. | . | L.W not very different in intensity from P.Ts. |
| | | eL | 21 | 31 | 30 | ... | .. | ... | .. | ... | |
| | | M | 21 | 36 | 54 | | .. | 40 | . | ... | |
| | | F | 22 | 55 | 06 | ... | ... | ... | ... | ... | |
| 13 | 28 ... | eP | | ... | | | ... | ... | ... | ... | |
| | | iL | 19 | 14 | 54 | ... | ... | ... | ... | ... | |
| | | M | 19 | 32 | 18 | .. | ... | 200 | ... | ... | |
| | | F | 20 | 38 | 12 | | .. | ... | ... | ... | |
| 14 | March 8 ... | eP | 16 | 09 | 42 | . | . . | ... | | ... | Widening of line. |
| | | F | 16 | 23 | 36 | .. | ... | .. | ... | ... | |
| 15 | 10 ... | eP | 1 | 16 | 24 | ... | . | .. | ... | ... | Widening of line. |
| | | F | 1 | 27 | 12 | ... | ... | ... | ... | ... | |
| 16 | 12 ... | eP | 15 | 03 | 12 | ... | ... | ... | ... | ... | |
| | | eL | 15 | 07 | 06 | ... | ... | ... | ... | ... | |
| | | M | 15 | 15 | 48 | ... | ... | 100 | | ... | |
| | | F | 16 | 05 | 48 | ... | ... | ... | ... | . . | |
| 17 | 17 ... | iP | 19 | 02 | 54 | ... | .. | .. | ... | ... | Widening of line. |
| | | F | 19 | 13 | 00 | ... | . | | ... | ... | |
| 18 | 18 ... | eP | 2 | 03 | 00 | .. | ... | ... | .. | ... | Hour mark broad. Probably a W L. superposed on it. |

* The instrument was not working satisfactorily during the month. From January 13th to February 5th it was under repairs and during this period record was obtained only on January 17th.

Kodaikanal Observatory Seismic Records—*cont.*

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period (Sec.). | Amplitude ($u$). AN. | AE. | AZ. | Distance △ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1915. | | | | | | | | | | |
| 19 | March 18 .. | P | | .. | | ... | . | . | ... | ... | |
| | | iL | 21 | 14 | 12 | ... | ... | ... | .. | ... | |
| | | M | 21 | 22 | 48 | ... | ... | 50 | ... | ... | |
| | | F | 21 | 38 | 48 | ... | ... | | | ... | |
| 20 | 26 ... | eP | 5 | 26 | 06 | | ... | . | ... | ... | Widening of line. |
| | | F | 5 | 28 | 42 | ... | ... | ... | ... | ... | |
| 21 | 30 ... | eP | 9 | 30 | 00? | ... | ... | ... | ... | ... | P.Ts. merged in hour mark. |
| | | eL | 9 | 33 | 06 | ... | ... | . | ... | ... | |
| | | M | 9 | 36 | 42 | ... | ... | 60 | ... | ... | |
| | | F | 9 | 52 | 54 | ... | ... | ... | ... | ... | |
| 22 | April 3 ... | eP | 13 | 48 | 06 | ... | ... | ... | ... | ... | |
| | | eL | 13 | 51 | 24 | . | | ... | ... | ... | |
| | | M | 13 | 57 | 06 | ... | ... | 120 | ... | .. | |
| | | F | 14 | 28 | 12 | ... | ... | ... | ... | ... | |
| 23 | 3 ... | oP | 21 | 20 | 30 | . | ... | ... | ... | ... | |
| | | eL | 21 | 24 | 36 | . . | ... | . | .. | ... | |
| | | M | 21 | 28 | 42 | ... | . | 40 | | ... | |
| | | F | 22 | 25 | 06 | ... | .. | ... | ... | ... | |
| 24 | 16 ... | eP | | ... | | ... | ... | ... | ... | ... | No P. Ts. |
| | | eL | 16 | 06 | 00 | | . | ... | ... | ... | |
| | | M | 14 | 07 | 30 | ... | ... | 20 | ... | ... | |
| | | F | 14 | 19 | 36 | .. | ... | ... | . | ... | |
| 25 | 17 ... | eP | 9 | 48 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 9 | 51 | 12 | | ... | ... | ... | ... | |
| 26 | 22 ... | eP | 19 | 01 | 00 | ... | ... | .. | ... | ... | |
| | | eL | 19 | 03 | 36 | ... | ... | ... | ... | ... | |
| | | M | 19 | 07 | 06 | ... | ... | 70 | ... | | |
| | | F | 19 | 39 | 12 | ... | ... | ... | .. | ... | |
| 27 | 23 ... | eP | 16 | 09 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 16 | 16 | 24 | .. | ... | ... | ... | ... | |
| 28 | 28 ... | eP | 3 | 33 | 42 | ... | ... | ... | ... | ... | |
| | | eL | 3 | 36 | 48 | . | ... | ... | . . | ... | |
| | | M | 3 | 39 | 36 | ... | ... | 40 | ... | ... | |
| | | F | 4 | 03 | 36 | ... | ... | ... | ... | .. | |
| 29 | 30 . | eP | 2 | 04 | 54 | ... | ... | ... | ... | ... | |
| | | iL | 2 | 05 | 48 | .. | ... | . . | ... | ... | |
| | | M | 2 | 07 | 18 | .. | .. | 50 | ... | ... | |
| | | F | 2 | 18 | 12 | ... | . | ... | ... | ... | |
| 30 | May 1 ... | iP | 5 | 11 | 54 | .. | ... | ... | ... | ... | |
| | | iL | 5 | 21 | 36 | ... | . | .. | ... | ... | |
| | | M | 5 | 44 | 48 | ... | ... | 710 | ... | ... | |
| | | | 5 | 48 | 06 | ... | ... | 1,010 | ... | ... | |
| | | | 5 | 53 | 00 | ... | ... | 1,020 | ... | ... | |
| | | | 5 | 58 | 06 | ... | ... | 850 | ... | ... | |
| | | | 6 | 02 | 30 | . | .. | 920 | ... | ... | |
| | | F | 10 | 03 | 54 | ... | ... | ... | ... | ... | |
| 31 | 2 ... | eP | 4 | 44 | 36 | ... | ... | ... | ... | ... | |
| | | eL | 4 | 46 | 06 | ... | ... | ... | ... | ... | |
| | | M | 4 | 47 | 54 | ... | ... | ... | ... | ... | |
| | | F | 5 | 04 | 18 | ... | ... | ... | ... | ... | |
| 32 | 3 ... | eP | 3 | 41 | 18 | ... | ... | ... | ... | ... | |
| | | eL | 4 | 02 | 12 | ... | ... | . | ... | ... | |
| | | M | 4 | 04 | 00 | .. | ... | 30 | .. | ... | |
| | | F | 5 | 39 | 36 | ... | ... | ... | ... | ... | |
| 33 | 3 ... | eP | 22 | 27 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 22 | 29 | 00 | ... | ... | ... | ... | ... | |
| 34 | 5 ... | eP | 11 | 27 | 24 | ... | ... | ... | ... | ... | |
| | | eL | 11 | 48 | 1[illegible] | ... | ... | ... | ... | ... | |
| | | M | 11 | 50 | 36 | ... | ... | 30 | ... | ... | |
| | | F | 12 | 07 | 36 | ... | ... | ... | ... | ... | |
| 35 | 5 ... | eP | 15 | 25 | 36 | ... | ... | ... | .. | . | |
| | | eL | 15 | 27 | 54 | .. | ... | ... | ... | ... | |
| | | M | 15 | 28 | 30 | ... | ... | 30 | ... | ... | |
| | | F | 15 | 46 | 12 | ... | ... | ... | ... | ... | |
| 36 | 8 ... | eP | 14 | 00 | 06 | ... | ... | ... | ... | ... | |
| | | eL | 14 | 08 | 54 | ... | ... | ... | ... | | |
| | | M | 14 | 13 | 18 | ... | ... | 60 | ... | ... | |
| | | F | 14 | 33 | 12 | ... | . | .. | ... | ... | |
| 37 | 12 ... | oP | 11 | 01 | 00 | ... | ... | ... | ... | ... | |
| | | eL | 11 | 10 | 48 | ... | ... | . | ... | ... | |
| | | M | 11 | 27 | 24 | ... | ... | 290 | ... | ... | |
| | | F | 12 | 19 | 12 | | ... | ... | ... | ... | |
| 38 | 14 ... | eP | 7 | 27 | 42 | ... | ... | ... | ... | ... | Widening of line. Hour mark superposed. |
| | | F | 7 | 48 | 36 | .. | ... | ... | ... | .. | |

Kodaikanal Observatory Seismic Records—*cont.*

| No. | Date. | Phase. | Time G.M.T. | | | Period (Sec.). | Amplitude (u) | | | Distance △ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | H. | M. | S. | | An. | Ae. | Az. | | |
| | 1915. | | | | | | | | | | |
| 39 | May 19 ... | eP | 5 | 16 | 36 | ... | ... | ... | ... | ... | Widening of line |
| | | F | 5 | 20 | 36 | ... | ... | ... | .. | ... | |
| 40 | 21 ... | eP | 3 | 38 | 12 | ... | ... | ... | .. | ... | |
| | | eL | 3 | 43 | 18 | ... | ... | ... | .. | ... | |
| | | M | 3 | 48 | 00 | ... | ... | 100 | ... | ... | |
| | | F | 4 | 21 | 18 | ... | ... | ... | ... | ... | |
| 41 | June 1 .. | eP | 15 | 17 | 00 | ... | . | .. | ... | ... | |
| | | eL | 15 | 29 | 12 | .. | ... | . | .. | .. | |
| | | M | 15 | 32 | 30 | ... | ... | 80 | ... | ... | |
| | | F | 16 | 20 | 00 | .. | ... | ... | ... | ... | |
| 42 | 6—7 ... | iP | 21 | 48 | 54 | .. | ... | ... | .. | ... | Air tremors due to high wind were frequent during 2nd half of June. |
| | | iL | 21 | 59 | 06 | ... | ... | ... | . | ... | |
| | | M | 22 | 53 | 12 | ... | ... | 340 | . | . | |
| | | F | 0 | 13 | 54 | ... | ... | .. | . | ... | |
| 43 | July 31 ... | eP | 1 | 42 | 54 | ... | | ... | ... | ... | |
| | | iL | 2 | 12 | 36 | | .. | | .. | ... | |
| | | M | 2 | 19 | 48 | .. | . | 340 | ... | ... | |
| | | F | 5 | 09 | 06 | ... | ... | ... | ... | ... | |
| 44 | August 3 ... | eP | 13 | 14 | 30 | ... | ... | . | ... | ... | |
| | | iL | 13 | 22 | 00 | ... | ... | .. | ... | .. | |
| | | M | 13 | 31 | 06 | ... | ... | 60 | ... | ... | |
| | | F | 14 | 41 | 36 | ... | ... | ... | ... | ... | |
| 45 | 6 ... | eP | 13 | 32 | 54 | ... | .. | ... | .. | ... | |
| | | eL | 13 | 57 | 42 | .. | ... | ... | ... | .. | |
| | | M | 13 | 58 | 42 | ... | ... | 50 | ... | .. | |
| | | F | 14 | 46 | 42 | ... | ... | ... | . | ... | |
| 46 | 11 ... | eP | 9 | 37 | 12 | ... | ... | ... | ... | ... | |
| | | eL | 9 | 41 | 54 | ... | ... | ... | . | ... | |
| | | M | 9 | 48 | 30 | ... | .. | 40 | ... | .. | |
| | | F | 10 | 04 | 30 | ... | ... | ... | ... | ... | |
| 47 | 12 ... | eP | 7 | 47 | 24 | ... | ... | ... | ... | ... | |
| | | iL | 7 | 58 | 54 | ... | ... | ... | ... | ... | |
| | | M | 8 | 03 | 42 | ... | ... | 140 | ... | ... | |
| | | F | 8 | 33 | 06 | ... | ... | ... | ... | ... | |
| 48 | 12 ... | iP | 9 | 22 | 48 | ... | ... | ... | ... | ... | |
| | | iL | 9 | 23 | 06 | ... | ... | | ... | ... | |
| | | M | 9 | 26 | 42 | .. | ... | 320 | ... | .. | |
| | | F | 9 | 58 | 06 | ... | ... | ... | ... | ... | |
| 49 | 12 ... | eP | 13 | 50 | 00 | ... | ... | . | ... | ... | |
| | | eL | 13 | 53 | 36 | ... | ... | ... | ... | ... | |
| | | M | 13 | 54 | 54 | | ... | 50 | ... | ... | |
| | | F | 14 | 12 | 00 | ... | ... | . | ... | ... | |
| 50 | 13 ... | P | | ... | | ... | ... | | ... | ... | |
| | | eL | 22 | 23 | 48 | . | .. | ... | ... | .. | |
| | | M | 22 | 24 | 48 | ... | . | 6 | ... | ... | |
| | | F | 22 | 30 | 00 | ... | ... | ... | ... | ... | |
| 51 | 16 ... | eP | 1 | 22 | 18 | | ... | ... | ... | . | Widening of line. |
| | | F | 2 | 19 | 00 | ... | ... | ... | .. | .. | |
| 52 | 19 ... | eP | 0 | 52 | 30 | .. | ... | ... | . | ... | Widening of line. |
| | | F | 1 | 14 | 54 | ... | ... | .. | .. | ... | |
| 53 | 31 ... | eP | 20 | 50 | 48 | ... | ... | ... | ... | ... | |
| | | eL | 21 | 05 | 36 | ... | ... | ... | | ... | |
| | | M | 21 | 10 | 30 | . | ... | 60 | . | ... | |
| | | F | 21 | 39 | 42 | ... | ... | ... | ... | ... | |
| 54 | September 1 ... | iP | 1 | 10 | 00 | ... | ... | ... | ... | ... | |
| | | iL | 1 | 10 | 06 | ... | ... | ... | .. | ... | |
| | | M | 1 | 12 | 00 | . | .. | 290 | ... | ... | |
| | | F | 1 | 37 | 12 | ... | . | ... | | ... | |
| 55 | 1 ... | eP | 2 | 05 | 54 | ... | ... | ... | | ... | |
| | | iL | 2 | 06 | 24 | .. | ... | ... | ... | | |
| | | M | 2 | 07 | 24 | ... | ... | 100 | ... | ... | |
| | | F | 2 | 16 | 36 | | .. | ... | . | ... | |
| 56 | 6 ... | eP | 18 | 02 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 18 | 50 | 42 | .. | .. | .. | | ... | |
| 57 | 7 ... | eP | 1 | 41 | 00 | .. | ... | ... | ... | . | |
| | | iL | 2 | 03 | 48 | ... | ... | ... | ... | ... | |
| | | M | 2 | 56 | 00 | ... | | 520 | ... | ... | |
| | | F | 3 | 36 | 00 | ... | ... | .. | ... | ... | |
| 58 | 12 ... | eP | 0 | 09 | 30 | .. | ... | ... | ... | ... | |
| | | eL | 0 | 16 | 42 | .. | ... | ... | | ... | |
| | | M | 0 | 17 | 18 | ... | ... | 40 | ... | ... | |
| | | F | 0 | 33 | 06 | ... | ... | ... | ... | ... | |
| 59 | 12 ... | eP | 21 | 42 | 48 | ... | .. | | ... | | Widening of line. |
| | | F | 22 | 15 | 36 | ... | .. | ... | ... | .. | |
| 60 | September 23 ... | eP | 8 | 29 | 00 | ... | .. | ... | ... | ... | Widening of line. |
| | | F | 8 | 49 | 24 | ... | .. | ... | ... | ... | |

## Kodaikanal Observatory Seismic Records—*cont.*

| No. | Date. | Phase. | Time G.M.T. | | | Period (Sec.). | Amplitude (u) | | | Distance △ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | An. | Ae. | Az. | | |
| | 1915. | | H. | M. | S. | | | | | | |
| 61 | October 3 ... | eP | 7 | 24 | 00 | ... | ... | ... | ... | ... | |
| | | iL | 7 | 57 | 30 | ... | ... | ... | ... | ... | |
| | | M | 8 | 15 | 48 | ... | ... | 350 | ... | ... | |
| | | F | 9 | 48 | 48 | ... | ... | ... | ... | ... | |
| 62 | 5 ... | eP | 14 | 08 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 14 | 58 | 30 | ... | ... | ... | ... | ... | |
| 63 | 11 ... | eP | 20 | 52 | 48 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 21 | 48 | 18 | ... | ... | ... | ... | ... | |
| 64 | November 1 ... | eP | 7 | 35 | 06 | ... | ... | ... | ... | ... | |
| | | iL | 7 | 55 | 36 | ... | ... | ... | ... | ... | |
| | | M | 8 | 08 | 54 | ... | ... | 290 | ... | ... | |
| | | F | 10 | 55 | 24 | ... | ... | ... | ... | ... | |
| 65 | 18 ... | eP | 4 | 21 | 30 | ... | ... | ... | ... | ... | |
| | | eL | 4 | 41 | 18 | ... | ... | ... | ... | ... | |
| | | M | 4 | 45 | 54 | ... | ... | 60 | ... | ... | |
| | | F | 5 | 17 | 12 | ... | ... | ... | ... | ... | |
| 66 | 18 ... | eP | 20 | 34 | 06? | ... | ... | ... | ... | ... | |
| | | eL | 20 | 40 | 30 | ... | ... | ... | ... | ... | |
| | | M | 20 | 45 | 24 | ... | ... | 50 | ... | ... | |
| | | F | 21 | 06 | 00 | ... | ... | ... | ... | ... | |
| 67 | 20 ... | eP | 15 | 53 | 36 | ... | ... | ... | ... | ... | |
| | | eL | 15 | 55 | 54 | ... | ... | ... | ... | ... | |
| | | M | 15 | 59 | 30 | ... | ... | 50 | ... | ... | |
| | | F | 16 | 13 | 36 | ... | ... | ... | ... | ... | |
| 68 | 21 ... | eP | 1 | 19 | 12 | ... | ... | ... | ... | ... | |
| | | eL | 1 | 35 | 36 | ... | ... | ... | ... | ... | |
| | | M | 1 | 39 | 42 | ... | ... | 190 | ... | ... | |
| | | F | 2 | 39 | 42 | ... | ... | ... | ... | ... | |
| 69 | December 3 ... | eP | 2 | 45 | 06 | ... | ... | ... | ... | ... | |
| | | iL | 2 | 49 | 30 | ... | ... | ... | ... | ... | |
| | | M | 2 | 54 | 06 | ... | ... | 190 | ... | ... | |
| | | F | 3 | 27 | 24 | ... | ... | ... | ... | ... | |
| 70 | 17 ... | eP | 7 | 16 | 36 | ... | ... | ... | ... | ... | |
| | | iL | 7 | 22 | 00 | ... | ... | ... | ... | ... | |
| | | M | 7 | 25 | 54 | ... | ... | 60 | ... | ... | |
| | | F | 7 | 52 | 42 | ... | ... | ... | ... | ... | |
| 71 | 18 ... | eP | 19 | 13 | 24 | ... | ... | ... | ... | ... | |
| | | F | 19 | 23 | 48 | ... | ... | ... | ... | ... | Widening of line. |
| 72 | 19 ... | eP | 20 | 21 | 18 | ... | ... | ... | ... | ... | |
| | | iL | 20 | 24 | 48 | ... | ... | ... | ... | ... | |
| | | M | 20 | 27 | 12 | ... | ... | 110 | ... | ... | |
| | | F | 20 | 55 | 12 | ... | ... | ... | ... | ... | |

# APPENDIX II.

Latitude 10° 13′ 50″ N.
Longitude 5h 9m 52s E.

Height of Barometer cistern
above mean sea level 7,688 feet.

## Mean Monthly and Annual Meteorological Results at the Kodaikanal Observatory in 1915.

| Month | Barometer. | | Dry Bulb Thermometer. | | | | Wet Bulb. | | Tension of Vapour. | Relative Humidity. | Sun Max. in *Vac.* | Min. on Grass. | Wind. | | | Rain. | | Clear Sky. | Bright Sun-shine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reduced to 32°. | Daily Range. | Mean. | Max. | Min. | Range. | Mean. | Min. | By Simpson's | Tables. | | | Daily Velo-city. | Mean Direction. | | Amount. | Days. | | |
| | Inches. | Inches. | ° | ° | ° | ° | ° | ° | Inches. | Cents. | ° | ° | Miles. | Points. | | Inches. | No. | Cents. | Hours. |
| January ... | 22·877 | 0·060 | 57·5 | 66·0 | 48·9 | 17·1 | 48·3 | 41·4 | 0·262 | 57 | 124·8 | 41·7 | 262 | 5 | N.E. by E. | 1·79 | 4 | 56 | 243·3 |
| February .. | ·867 | ·066 | 58·5 | 67·6 | 49·5 | 18·1 | 49·6 | 43·3 | ·278 | 59 | 131·4 | 41·6 | 223 | 1 | N. by E. | 0·52 | 2 | 59 | 238·9 |
| March .. ... | ·905 | ·067 | 60·3 | 69·5 | 51·0 | 18·5 | 52·0 | 44·9 | ·318 | 62 | 136·2 | 43·0 | 232 | 9 | E. by S. | 3·47 | 7 | 65 | 274·3 |
| April .. ... | ·865 | ·061 | 62·4 | 71·4 | 53·5 | 17·9 | 54·1 | 48·1 | ·346 | 63 | 139·9 | 46·6 | 258 | 6 | E.N.E. | 3·92 | 4 | 69 | 277·0 |
| May ... ... | ·819 | ·060 | 64·0 | 72·3 | 55·6 | 16·7 | 55·3 | 49·7 | ·362 | 63 | 138·2 | 48·9 | 247 | 29 | N.W. by N. | 1·28 | 4 | 59 | 278·7 |
| June ... ... | ·769 | ·065 | 61·1 | 67·7 | 54·6 | 13·1 | 56·1 | 51·7 | ·410 | 79 | 130·5 | 51·3 | 351 | 26 | W.N.W. | 6·05 | 12 | 30 | 157·2 |
| July ... ... | ·777 | ·056 | 58·9 | 64·1 | 53·7 | 10·4 | 55·5 | 51·8 | ·414 | 86 | 121·7 | 49·9 | 289 | 22 | W.S.W. | 6·22 | 14 | 19 | 109·4 |
| August ... ... | ·785 | ·061 | 58·7 | 64·1 | 53·2 | 10·9 | 55·6 | 51·3 | ·418 | 86 | 125·2 | 49·5 | 231 | 26 | W.N.W. | 6·79 | 15 | 24 | 134·4 |
| September ... | ·785 | ·077 | 59·7 | 65·7 | 53·7 | 12·0 | 55·4 | 51·2 | ·408 | 83 | 129·8 | 49·6 | 265 | 25 | W. by N. | 6·07 | 12 | 19 | 153·9 |
| October ... | ·806 | ·068 | 59·0 | 66·1 | 51·8 | 14·3 | 54·4 | 49·0 | ·387 | 79 | 131·6 | 42·9 | 203 | 17 | S. by W. | 4·24 | 9 | 43 | 203·8 |
| November ... | ·809 | ·073 | 56·7 | 61·8 | 51·7 | 10·1 | 53·9 | 50·1 | ·399 | 90 | 117·5 | 43·3 | 214 | 29 | N.W. by W. | 8·03 | 16 | 16 | 115·8 |
| December ... | ·842 | ·064 | 54·3 | 62·5 | 46·2 | 16·3 | 48·6 | 41·6 | ·294 | 70 | 115·9 | 36·4 | 260 | 6 | E.N.E. | 5·32 | 8 | 54 | 215·5 |
| Annual ... | 22·825 | 0·065 | 59·3 | 66·6 | 51·9 | 14·6 | 53·2 | 47·8 | 0·358 | 73 | 128·6 | 45·8 | 253 | 30 | N.N.W. | 53·70 | 107 | 43 | 2402·2 |

## Extreme Monthly Meteorological Records at the Kodaikanal Observatory in 1915.

| Month. | Barometer. | | | | | Dry Bulb Thermometer. | | | | Wet Bulb. | | Humidity. | | Sun Th. in *Vacuo.* | | Grass Therm. | | Wind. | | | | Rain. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | | Lowest. | | Range. | Highest. | | Lowest. | | Lowest. | | Lowest. | | Highest. | | Lowest. | | Highest. | | Lowest. | | Greatest Fall. | |
| | Inches. | Day. | Inches. | Day. | Inches. | ° | Day. | ° | Day. | ° | Day. | Cents. | Day. | ° | Day. | ° | Day. | Miles. | Day. | Miles. | Day. | Inches. | Day. |
| January ... | **22·980** | **18** | 22·814 | 31 | 0·166 | 73·7 | 8 | 42·3 | 12 | 34·6 | 27 | **10** | 3 | 139·9 | **6** | 30·4 | 12 | 495 | 1 | 110 | 18 | 0·47 | 19 |
| February ... | ·920 | 9 | ·800 | 4 | ·120 | 74·6 | 18 | 43·9 | 1 | 35·2 | 26 | 16 | 15 | 142·1 | 28 | 35·1 | 1 | 343 | 11 | 84 | **7** | 0·21 | 7 |
| March .. ... | ·966 | 18, 19 | ·835 | 1 | ·131 | 73·4 | 25 | 46·1 | 7 | 38·7 | 21 | 29 | 21 | 145·5 | 31 | 33·2 | 9 | 430 | 20 | 116 | 10 | 0·93 | 1 |
| April ... .. | ·943 | 6 | ·759 | 19 | ·184 | 75·0 | 3 | 49·2 | 8 | 39·2 | 8 | 24 | 13 | 146·4 | 8 | 39·1 | 8 | 418 | 14 | 128 | 18 | **2·99** | **16** |
| May ... . | ·895 | 20 | ·697 | 9 | ·198 | **77·2** | **24, 29** | 52·8 | 22 | 43·1 | 23 | 29 | 22 | **156·0** | **1** | 42·8 | 21 | 449 | 10 | 98 | 15 | 0·37 | 6 |
| June .. .. | ·850 | 30 | ·660 | 23 | ·190 | 74·5 | 11 | 52·3 | 28, 29 | 49·3 | 30 | 46 | 1 | 144·8 | 12 | 47·7 | 5 | **659** | **17** | 84 | 13 | 1·31 | 14 |
| July .. ... | ·874 | 11 | **·615** | **20** | ·259 | 70·0 | 5 | 51·9 | 12 | 46·4 | 4 | 43 | 3 | 147·9 | 5 | 41·2 | 4 | 529 | 29 | 102 | 7 | 1·04 | 6 |
| August ... | 886 | 31 | ·706 | 22 | ·180 | 68·2 | 10 | 50·6 | 19 | 47·1 | 19 | 69 | 11 | 143·9 | 8 | 43·4 | 29 | 587 | 2 | 89 | 16 | 1·16 | 22 |
| September ... | 888 | 2 | ·686 | 10 | ·202 | 70·6 | 27 | 51·6 | 2 | 44·7 | 3 | 44 | 3 | 152·3 | 27 | 44·4 | 1, 2 | 450 | 12 | 92 | 15 | 0·99 | 20 |
| October ... ... | 870 | 13 | ·709 | 10 | ·161 | 69·5 | 11, 15 | 48·2 | 15 | 42·3 | 3 | 42 | 3 | 147·3 | 9 | 38·4 | 14 | 523 | 2 | 109 | 10 | 1·14 | 20 |
| November | ·898 | 29 | ·662 | 5 | **·236** | **67·1** | 9 | 47·9 | 30 | 45·8 | **6** | **54** | 6 | 127·9 | 25 | 44·0 | 30 | **347** | 5 | **69** | **26** | 1·22 | 27 |
| December ... | ·914 | 11 | ·754 | 6 | ·160 | 72·4 | 6 | **39·6** | **15** | **32·6** | **7** | 20 | 11 | 132·9 | 4 | **20·2** | **15** | 464 | 25 | 112 | 9 | 1·24 | 26 |

# APPENDIX III.

KODAIKANAL mean hourly wind velocity for the year 1915.

| Month. | Hours. | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| January ... | 11 | 13 | 12 | 12 | 13 | 11 | 13 | 12 | 12 | 15 | 13 | 13 | 12 | 10 | 9 | 9 | 7 | 7 | 8 | 9 | 9 | 10 | 10 | 10 |
| February ... | 10 | 11 | 10 | 10 | 10 | 10 | 9 | 10 | 9 | 12 | 11 | 11 | 11 | 11 | 10 | 8 | 6 | 6 | 6 | 6 | 7 | 8 | 9 | 10 |
| March ... | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 10 | 11 | 11 | 12 | 13 | 11 | 10 | 11 | 13 | 7 | 7 | 8 | 10 | 10 | 10 | 9 | 9 |
| April ... | 11 | 11 | 12 | 12 | 11 | 11 | 12 | 12 | 12 | 14 | 15 | 14 | 12 | 10 | 10 | 10 | 9 | 9 | 9 | 9 | 8 | 8 | 9 | 10 |
| May ... | 10 | 12 | 10 | 10 | 10 | 10 | 9 | 9 | 11 | 11 | 12 | 12 | 11 | 11 | 11 | 12 | 9 | 9 | 8 | 10 | 9 | 10 | 9 | 10 |
| June ... | 15 | 17 | 15 | 15 | 15 | 15 | 14 | 14 | 15 | 13 | 14 | 14 | 13 | 14 | 14 | 13 | 12 | 13 | 14 | 15 | 15 | 16 | 17 | 17 |
| July ... | 14 | 13 | 14 | 14 | 12 | 13 | 12 | 13 | 11 | 11 | 11 | 11 | 10 | 11 | 11 | 11 | 10 | 11 | 11 | 12 | 12 | 14 | 13 | 13 |
| August ... | 11 | 11 | 11 | 11 | 11 | 10 | 10 | 9 | 7 | 9 | 10 | 10 | 9 | 8 | 9 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 12 | 12 |
| September ... | 11 | 11 | 12 | 12 | 12 | 12 | 13 | 11 | 11 | 11 | 11 | 10 | 10 | 10 | 10 | 9 | 10 | 10 | 11 | 12 | 12 | 11 | 11 | 12 |
| October ... | 10 | 10 | 9 | 9 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 8 | 9 | 8 | 7 | 7 | 8 | 9 | 8 | 9 | 9 | 9 |
| November ... | 10 | 10 | 9 | 10 | 10 | 9 | 9 | 8 | 9 | 9 | 8 | 9 | 8 | 8 | 7 | 8 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 10 |
| December ... | 10 | 10 | 10 | 11 | 10 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 12 | 11 | 12 | 10 | 9 | 9 | 10 | 11 | 10 | 11 | 11 | 10 |
| Annual ... | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 12 | 11 | 11 | 10 | 10 | 10 | 9 | 9 | 9 | 10 | 10 | 11 | 11 | 11 |

## APPENDIX IV.

KODAIKANAL mean hourly bright sunshine for the year 1915.

| Month. | 6–7 | 7–8 | 8–9 | 9–10 | 10–11 | 11–12 | 12–13 | 13–14 | 14–15 | 15–16 | 16–17 | 17–18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hours. | | | | | | | | | | | |
| January ... ... .. | 0·26 | 0·72 | 0·83 | 0·88 | 0·82 | 0·80 | 0·76 | 0·78 | 0·72 | 0·66 | 0·51 | 0·09 |
| February ... ... ... | ·38 | ·79 | ·83 | ·83 | ·90 | ·86 | ·93 | ·86 | ·74 | ·69 | ·51 | ·21 |
| March ... ... ... ... | ·57 | ·89 | ·92 | ·96 | ·98 | ·94 | ·85 | ·77 | ·71 | ·60 | 39 | ·25 |
| April ... ... ... ... | ·54 | ·91 | ·97 | ·96 | ·98 | ·99 | ·91 | ·82 | ·70 | ·63 | ·55 | ·27 |
| May ... ... ... ... | ·57 | ·92 | ·94 | ·98 | ·93 | ·91 | ·86 | ·77 | ·67 | ·60 | ·52 | ·34 |
| June ... ... ... ... | ·25 | ·53 | ·62 | ·61 | ·66 | ·67 | ·52 | ·41 | ·41 | ·33 | ·20 | ·04 |
| July ... ... ... ... | ·17 | ·46 | ·51 | ·51 | ·45 | ·28 | ·31 | ·21 | ·25 | ·19 | ·12 | ·06 |
| August ... ... ... ... | ·17 | ·47 | ·59 | ·67 | ·61 | ·53 | ·30 | ·25 | ·21 | ·27 | ·19 | ·06 |
| September ... ... ... | ·16 | ·38 | ·60 | 69 | ·69 | ·62 | ·57 | ·48 | ·36 | ·27 | ·23 | ·09 |
| October ... ... ... ... | ·30 | ·76 | ·85 | ·85 | ·72 | ·70 | ·60 | ·54 | ·49 | ·38 | ·24 | ·12 |
| November ... ... ... | ·08 | ·38 | ·48 | ·62 | ·52 | ·49 | ·36 | ·33 | ·33 | ·17 | ·09 | ·02 |
| December ... ... ... | ·22 | ·65 | ·65 | ·69 | ·74 | ·76 | ·72 | ·68 | ·66 | ·59 | ·51 | ·08 |
| Mean .. | 0·31 | 0·66 | 0·73 | 0·77 | 0·75 | 0·71 | 0·64 | 0·58 | 0·52 | 0·45 | 0·34 | 0·14 |

## APPENDIX V.

NUMBER of days in each month on which the Nilgiris were visible in 1915.

| Month. | Very clear. | Visible. | Just visible. | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January ... ... | 5 | 10 | 2 | 1 | 18 |
| February ... ... | ... | 4 | 3 | 1 | 8 |
| March ... ... | ... | 2 | 8 | 1 | 11 |
| April ... ... | 1 | 3 | 2 | ... | 6 |
| May ... ... | 1 | 1 | 4 | ... | 6 |
| June ... ... | 3 | 2 | 3 | ... | 8 |
| July ... ... | 6 | 7 | ... | ... | 13 |
| August ... ... | ... | 1 | 6 | ... | 7 |
| September ... | 6 | 4 | 4 | ... | 14 |
| October ... ... | 1 | 15 | 2 | 1 | 19 |
| November ... | 1 | 1 | 2 | ... | 4 |
| December ... ... | ... | 15 | ... | ... | 15 |
| Total ... | 24 | 65 | 36 | 4 | 129 |

# APPENDIX VI.

MADRAS OBSERVATORY—Abnormals from monthly means for the year 1915.

| Abnormals of | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November | December | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure ... ... ... | + 0·024 | − 0·005 | + 0·052 | + 0·032 | − 0·030 | − 0·023 | + 0·001 | − 0·017 | − 0·027 | − 0·051 | − 0·073 | + 0·010 | − 0·009 |
| Temperature of air ... ... ... .. ... | + 1·2 | + 1·8 | + 1·8 | + 0·7 | + 2·9 | + 1·8 | + 0·2 | + 2·1 | + 0·8 | + 2·9 | + 1·6 | + 0·8 | + 1·6 |
| Do. of evaporation ... ... ... | + 2·7 | + 2·4 | + 2·6 | + 1·3 | + 1·9 | + 3·0 | + 2·1 | + 2·3 | + 1·6 | + 2·4 | + 2·6 | − 0·2 | + 2·1 |
| Percentage of humidity ... ... ... ... | + 7 | + 4 | + 3 | + 2 | − 2 | + 5 | + 9 | + 2 | + 4 | Same as | + 6 | − 3 | + 3 |
| Greatest solar heat in *vacuo* ... ... ... | + 8·1 | + 10·0 | + 13·0 | + 13·1 | + 10·2 | + 6·1 | + 5·5 | + 8·5 | + 9·6 | + 13·4 | + 1·2 | + 9·6 | + 9·0 |
| Maximum in shade ... ... ... ... ... | − 0·5 | + 0·1 | + 1·1 | + 0·6 | + 4·0 | Same as | − 1·4 | + 1·8 | − 0·3 | + 2·9 | + 1·0 | + 0·8 | + 0·8 |
| Minimum in shade ... ... ... .. ... | + 2·4 | + 3·1 | + 2·1 | + 0·3 | + 1·8 | + 2·3 | + 0·2 | + 1·8 | + 0·3 | + 1·8 | + 1·8 | + 0·1 | + 1·5 |
| Do. on grass ... ... ... .. ... | + 6·2 | + 4·4 | + 3·2 | + 0·9 | + 2·4 | + 2·8 | + 0·8 | + 2·9 | + 1·1 | + 2·0 | + 2·9 | + 0·6 | + 2·5 |
| Rainfall in inches ... ... ... ... ... | + 8·72 | + 0·02 | − 0·15 | − 0·10 | − 1·76 | − 0·80 | + 4·93 | − 3·36 | + 5·74 | − 8·36 | + 7·58 | − 4·87 | ... |
| Do. since January 1st ... ... ... ... | ... | + 8·74 | + 8·59 | + 8·49 | + 6·73 | + 5·93 | + 10·86 | + 7·50 | + 13·24 | + 4·88 | + 12·46 | + 7·59 | + 7·59 |
| General direction of wind .. ... .. ... | 1 point N. | 1 point N. | 1 point E. | Same as | 1 point S. | 2 points S. | 1 point S. | 1 point S. | 3 points S. | 8 points S. | 2 points E. | Same as | Same as |
| Daily velocity in miles ... ... ... ... | + 1 | − 4 | − 24 | − 32 | − 37 | − 27 | − 27 | − 23 | − 23 | − 16 | − 48 | − 14 | − 23 |
| Percentage of cloudy sky ... .. ... ... | + 15 | + 5 | − 2 | − 12 | − 9 | − 14 | − 9 | − 11 | − 1 | − 12 | Same as | − 16 | − 6 |
| Do. of bright sunshine ... ... ... | − 12·2 | − 6·7 | + 0·3 | + 12·8 | + 3·3 | + 0·3 | + 2·1 | + 4·7 | + 2·9 | + 10·0 | − 6·2 | + 5·7 | − 3·0 |

+ means above normal; — means below normal.

# APPENDIX VII.

ABSTRACT of the Mean Meteorological Condition of Madras in the year 1915 compared with the average of past years.

| Mean values of | 1915. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure ... ... ... ... ... | 29 855 | 0·009 below. | 29·864 |
| Temperature of air ... .. ... ... ... ... ... | 82·7 | 1·6 above. | 81·1 |
| Do. of evaporation ... ... ... ... ... | 76 6 | 2·1 „ | 74·5 |
| Percentage of humidity .. ... .. ... ... ... | 75 | 3 „ | 72 |
| Greatest solar heat in *vacuo* ... ... ... ... ... | 148·7 | 9·0 „ | 139·7 |
| Maximum in shade ... ... ... ... ... ... ... | 91·6 | 0·8 „ | 90·8 |
| Minimum in shade ... ... ... .. ... ... ... | 76·2 | 1·5 „ | 74·7 |
| Do. on grass ... ... ... ... ... ... ... | 74·4 | 2·5 „ | 71·9 |
| Rainfall in inches since January 1st on 92 days ... ... | 56·61 | 7·59 „ | 49·02 |
| General direction of wind .. ... ... ... ... ... | S.E. | Same as | S.E. |
| Daily velocity in miles ... ... ... ... ... ... | 148 | 23 below | 171 |
| Percentage of cloudy sky ... ... ... ... ... ... | 43 | 6 „ | 49 |
| Do. of bright Sunshine ... ... ... ... ... | 55·4 | 3·0 „ | 58·4 |

DURATION and Quantity of the Wind from different Points.

| From. | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North ... | 188 | 1,149 | East ... | 256 | 1,223 | South ... | 206 | 1,336 | West ... | 194 | 1,325 |
| N. by E. ... | 270 | 1,512 | E. by S. | 332 | 1,582 | S. by W. | 230 | 1,513 | W. by N. | 166 | 1,196 |
| N.N.E. ... | 371 | 2,271 | E.S.E. ... | 266 | 1,382 | S.S.W. ... | 272 | 1,723 | W.N.W. | 115 | 798 |
| N.E. by N.... | 499 | 3,599 | S.E. by E. | 480 | 2,408 | S.W. by S. | 257 | 1,752 | N.W. by W. | 60 | 398 |
| N.E. ... | 258 | 1,869 | S.E. ... | 496 | 2,923 | S.W. ... | 225 | 1,476 | N.W. ... | 50 | 196 |
| N.E. by E.... | 225 | 1,399 | S.E. by S. | 935 | 6,719 | S.W. by W. | 199 | 1,372 | N.W. by N. | 76 | 372 |
| E.N.E. ... | 173 | 929 | S.S.E. ... | 574 | 4,298 | W.S.W. ... | 238 | 1,547 | N.N.W. ... | 83 | 441 |
| E. by N. ... | 290 | 1,476 | S. by E. | 254 | 1,742 | W. by S. | 253 | 1,823 | N. by W. | 96 | 528 |

There were 173 calm hours during the year. The resultant corresponding to the above numbers is represented by a S.E. by S.wind, blowing with a uniform daily velocity of 43 miles.

# APPENDIX VIII.

MADRAS OBSERVATORY—Number of hours of wind from each point in the year 1915.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January ... | 32 | 56 | 132 | 161 | 74 | 17 | 40 | 101 | 50 | 25 | 25 | ... | ... | ... | ... | ... | ... | .. | .. | ... | .. | ... | ... | ... | ... | ... | ... | ... | ... | .. | 7 | 6 | 18 |
| February ... | 1 | 10 | 24 | 75 | 62 | 80 | 66 | 76 | 62 | 60 | 28 | 101 | 2 | 1 | 3 | 2 | ... | ... | 1 | ... | ... | 2 | ... | ... | ... | ... | ... | ... | ... | ... | . | ... | 16 |
| March ... | ... | ... | 17 | ... | ... | 13 | 20 | 17 | 59 | 102 | 82 | 50 | 58 | 157 | 76 | 8 | 12 | 12 | 11 | 6 | 5 | 1 | 2 | ... | ... | ... | ... | ... | ... | 1 | ... | ... | 35 |
| April ... | .. | ... | ... | ... | ... | ... | ... | ... | ... | 20 | 25 | 104 | 43 | 294 | 138 | 19 | 15 | 12 | 14 | 8 | 2 | 2 | 1 | ... | ... | ... | ... | ... | ... | .. | .. | ... | 23 |
| May ... ... | ... | 2 | 1 | .. | 2 | 6 | 1 | 4 | 9 | 36 | 12 | 40 | 91 | 162 | 84 | 36 | 27 | 27 | 11 | 17 | 13 | 14 | 4 | 23 | 22 | 33 | 20 | 8 | 9 | 20 | 2 | 1 | 7 |
| June ... ... | ... | ... | 4 | ... | ... | 2 | 4 | 1 | 2 | 6 | 13 | 15 | 52 | 87 | 103 | 49 | 40 | 26 | 40 | 43 | 29 | 31 | 61 | 36 | 29 | 20 | 7 | 10 | 2 | 3 | 3 | ... | 2 |
| July ... ... | ... | 1 | 1 | ... | 1 | 3 | ... | 1 | 2 | 4 | 5 | 11 | 29 | 43 | 38 | 32 | 23 | 47 | 58 | 73 | 89 | 53 | 47 | 62 | 52 | 25 | 10 | 6 | 6 | 13 | 1 | 2 | 6 |
| August ... | 2 | ... | 1 | 1 | . | 1 | ... | 6 | 11 | 11 | 12 | 50 | 51 | 55 | 37 | 22 | 25 | 30 | 25 | 47 | 24 | 49 | 61 | 75 | 38 | 37 | 37 | 13 | 3 | 13 | 1 | 1 | 5 |
| September ... | 1 | 10 | 2 | 2 | ... | ... | 1 | 6 | 20 | 31 | 23 | 56 | 70 | 59 | 47 | 39 | 42 | 43 | 62 | 32 | 39 | 20 | 24 | 21 | 17 | 18 | 7 | 9 | 1 | 1 | 2 | ... | 15 |
| October ... | 4 | 14 | 32 | 39 | 18 | 6 | 3 | 14 | 16 | 7 | 16 | 20 | 92 | 55 | 44 | 35 | 14 | 28 | 49 | 29 | 22 | 13 | 19 | 32 | 32 | 21 | 32 | 12 | 9 | 4 | 2 | 3 | 8 |
| November ... | 45 | 42 | 33 | 40 | 31 | 45 | 32 | 56 | 25 | 30 | 25 | 33 | 8 | 22 | 4 | 12 | 8 | 5 | 1 | 2 | 2 | 14 | 19 | 4 | 4 | 12 | 2 | 2 | 20 | 9 | 45 | 56 | 32 |
| December ... | 103 | 135 | 124 | 181 | 70 | 52 | 6 | 8 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 12 | 20 | 27 | 6 |
| Annual total. | 188 | 270 | 371 | 499 | 258 | 225 | 173 | 290 | 256 | 332 | 266 | 480 | 496 | 935 | 574 | 254 | 206 | 230 | 272 | 257 | 225 | 199 | 238 | 253 | 194 | 166 | 115 | 60 | 50 | 76 | 83 | 96 | 173 |

# APPENDIX IX.

Madras Observatory—Number of miles of wind from each point in the year 1915.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January ... ... | 231 | 341 | 817 | 1,089 | 530 | 170 | 238 | 530 | 193 | 157 | 86 | ... | .. | ... | ... | ... | ... | .. | ... | ... | ... | ... | .. | . | ... | .. | . | ... | | ... | 61 | 53 | 4,496 |
| February ... ... | 9 | 88 | 140 | 402 | 313 | 450 | 355 | 421 | 302 | 256 | 150 | 358 | 12 | 8 | 18 | 13 | .. | | 7 | ... | ... | 12 | ... | ... | .. | ... | ... | . | ... | ... | ... | ... | 3,314 |
| March .. .. | ... | ... | 39 | ... | ... | 19 | 84 | 76 | 267 | 468 | 391 | 230 | 299 | 968 | 641 | 68 | 99 | 118 | 110 | 39 | 33 | 12 | 8 | ... | ... | ... | .. | ... | .. | 6 | ... | ... | 3,975 |
| April ... ... ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 87 | 160 | 525 | 339 | 1,923 | 1,061 | 197 | 123 | 112 | 141 | 66 | 18 | 10 | 5 | ... | ... | .. | ... | ... | ... | ... | ... | ... | 4,767 |
| May ... ... | ... | 17 | 7 | ... | 17 | 60 | 12 | 26 | 82 | 223 | 98 | 330 | 651 | 1,469 | 717 | 267 | 191 | 187 | 84 | 143 | 84 | 90 | 33 | 153 | 191 | 333 | 219 | 71 | 51 | 67 | 20 | 9 | 5,902 |
| June ... ... ... | ... | ... | 22 | ... | ... | 10 | 31 | 1 | 10 | 47 | 83 | 120 | 374 | 905 | 816 | 38[illegible] | 269 | 216 | 298 | 310 | 248 | 291 | 414 | 303 | 218 | 187 | 70 | 102 | 16 | 23 | 22 | ... | 5,795 |
| July .. ... ... | ... | 3 | 8 | ... | 9 | 25 | ... | 10 | 14 | 27 | 49 | 89 | 248 | 334 | 341 | 243 | 183 | 289 | 344 | 491 | 542 | 408 | 348 | 508 | 364 | 165 | 93 | 36 | 37 | 64 | 3 | 12 | 5,287 |
| August ... ... | 14 | ... | 5 | 3 | . | 9 | ... | 43 | 81 | 61 | 74 | 359 | 284 | 388 | 237 | 112 | 120 | 138 | 134 | 296 | 149 | 253 | 410 | 549 | 282 | 264 | 261 | 63 | 19 | 58 | 2 | 3 | 4,671 |
| September .. .. | 10 | 42 | 18 | 7 | ... | ... | 8 | 19 | 60 | 132 | 145 | 231 | 388 | 344 | 230 | 247 | 209 | 303 | 431 | 264 | 281 | 162 | 133 | 85 | 75 | 69 | 34 | 43 | 6 | 2 | 20 | ... | 3,998 |
| October ... ... | 29 | 56 | 161 | 207 | 144 | 58 | 26 | 60 | 67 | 17 | 44 | 54 | 288 | 247 | 218 | 133 | 84 | 115 | 170 | 118 | 105 | 75 | 94 | 199 | 172 | 123 | 111 | 70 | 18 | 23 | 7 | 19 | 3,312 |
| November ... ... | 187 | 261 | 203 | 335 | 176 | 236 | 108 | 232 | 147 | 107 | 102 | 112 | 40 | 133 | 19 | 73 | 58 | 35 | 4 | 25 | 16 | 59 | 102 | 26 | 23 | 55 | 10 | 13 | 49 | 53 | 226 | 296 | 3,521 |
| December ... ... | 669 | 704 | 851 | 1,556 | 680 | 362 | 67 | 58 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | . | ... | ... | ... | ... | ... | .. | ... | ... | 76 | 80 | 136 | 5,239 |
| Annual ... | 1,149 | 1,512 | 2,271 | 3,599 | 1,869 | 1,399 | 929 | 1,476 | 1,223 | 1,582 | 1,332 | 2,408 | 2,923 | 6,719 | 4,298 | 1,742 | 1,336 | 1,513 | 1,723 | 1,752 | 1,476 | 1,372 | 1,547 | 1,823 | 1,325 | 1,196 | 798 | 398 | 196 | 372 | 441 | 528 | 54,277 |

# APPENDIX X.

MADRAS OBSERVATORY—Number of inches of rain from each point in the year 1915.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January ... | 0·07 | 2·04 | 3·55 | 0·85 | 2·10 | 0·12 | 0·09 | 0·38 | ... | 0·37 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·01 | 0·03 | ... |
| February ... | ... | ... | ... | ... | 0·10 | ... | ... | ... | 0·08 | ... | ... | 0·12 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| March ... | ... | ... | 0·03 | ... | ... | 0·13 | ... | ... | 0·04 | ... | ... | ... | ... | 0·03 | ... | ... | ... | ... | ... | ... | 0·01 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| April ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·44 | 0·04 | ... | ... | ... | ... | 0·04 | ... | ... | ... | ... | ... | | ... | ... | ... | | ... | ... | ... | ... | ... |
| May ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·32 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·02 | ... | ... | ... | 0·02 | ... | | ... |
| June ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·02 | ... | 0·05 | | ... | 0·06 | ... | 0·08 | 0·06 | ... | 0·05 | 0·21 | ... | 0·02 | ... | 0·54 | 0·02 | 0·10 | ... | 0·10 | ... | ... |
| July ... | ... | ... | 0·25 | ... | ... | 0·94 | ... | ... | 0·07 | ... | ... | ... | ... | 0·11 | 0·08 | 0·46 | 0·06 | 0·63 | 0·06 | 0·52 | 0·12 | 0·01 | 1·24 | 1·78 | 1·11 | 0·19 | 0·08 | 0·04 | ... | 0·99 | 0·06 | ... | ... |
| August ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·17 | 0·01 | | ... | 0·05 | 0·02 | | ... | ... | 0·13 | ... | ... | ... | ... | ... | 0·03 | 0·09 | 0·15 | 0·04 | 0·06 | 0·08 | 0·36 | | 0·01 | ... |
| September .. | 0·01 | ... | 0·03 | ... | ... | ... | ... | ... | 0·06 | 0·02 | 1·05 | 0·05 | 0·16 | 0·02 | ... | 0·20 | 1·54 | 0·33 | 0·81 | 0·73 | 0·99 | 0·01 | 0·46 | 0·01 | ... | 1·20 | 1·71 | ... | ... | ... | ... | ... | 1·04 |
| October ... | ... | ... | ... | ... | 0·08 | ... | ... | 0·05 | ... | ... | ... | ... | ... | 0·23 | 0·12 | 0·03 | ... | 0·04 | 0·12 | 0·09 | ... | 0·06 | ... | ... | 0·13 | 0·02 | 0·18 | 0·07 | 0·59 | 0·83 | ... | ... | ... |
| November ... | 0·66 | 3·33 | 1·48 | 1·16 | 0·10 | 0·15 | ... | 0·51 | 1·37 | 0·54 | 0·19 | 2·94 | 0·17 | 1·68 | 0·35 | ... | ... | ... | ... | 0·30 | ... | 0·39 | 0·38 | 0·09 | 0·06 | 0·43 | ... | 0·19 | ... | 0·26 | 0·70 | 3·36 | 0·01 |
| December ... | 0·12 | ... | ... | 0·08 | 0·17 | 0·04 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Annual .. | 0·86 | 5·37 | 5·34 | 2·09 | 2·55 | 1·38 | 0·09 | 0·94 | 1·79 | 0·94 | 1·24 | 3·57 | 0·42 | 2·46 | 0·55 | 0·69 | 1·66 | 1·17 | 1·07 | 1·70 | 1·12 | 0·51 | 2·29 | 1·91 | 1·41 | 2·01 | 2·55 | 0·38 | 0·77 | 2·46 | 0·87 | 3·40 | 1·05 |

# APPENDIX XI.

## Madras Observatory—Wind, cloud and bright sunshine, 1915.

| Month. | Wind resultant. | | Clouds (0—10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H. | 16 H. | 20 H. | Mean. | Average per day. | Greatest number of hours in a day. |
| | MILES. | POINTS. | | | | | | HOURS. | HOURS. |
| January ... ... | 128 | N.E. | 5·5 | 5·5 | 4·9 | 4·6 | 5·2 | 6·4 | 9·0 |
| February ... ... | 99 | E.N.E. | 2·4 | 3·7 | 3·3 | 2·3 | 2·9 | 8·2 | 10·4 |
| March ... ... | 104 | E.S.E. | 2·6 | 3·0 | 1·4 | 1·6 | 2·2 | 8·9 | 10·7 |
| April ... ... | 148 | S.E. by S. | 2·3 | 2·6 | 0·8 | 0·7 | 1·6 | 10·2 | 11·3 |
| May ... ... | 103 | S.S.E. | 3·1 | 2·6 | 3·1 | 2·6 | 2·9 | 8·1 | 10·2 |
| June ... ... | 122 | S. by W. | 5·0 | 4·6 | 4·7 | 5·6 | 5·0 | 5·1 | 8·3 |
| July .. ... | 103 | S.W. by W. | 6·2 | 5·7 | 6·0 | 6·7 | 6·2 | 4·3 | 9·4 |
| August ... ... | 71 | S.W. by W. | 5·4 | 4·9 | 6·6 | 5·4 | 5·6 | 5·5 | 9·8 |
| September ... ... | 93 | South. | 6·3 | 6·2 | 6·0 | 5·7 | 6·1 | 5·4 | 10·3 |
| October ... ... | 23 | South. | 4·3 | 5·2 | 5·1 | 4·1 | 4·7 | 7·1 | 10·6 |
| November ... ... | 56 | N.E. by N. | 5·7 | 6·6 | 6·0 | 5·4 | 5·9 | 4·8 | 9·8 |
| December ... ... | 158 | N.N.E. | 3·8 | 3·9 | 3·7 | 3·1 | 3·6 | 6·6 | 8·9 |
| Annual ... | 43 | S.E. by S. | 4·4 | 4·5 | 4·3 | 4·0 | 4·3 | 6·7 | ... |

# APPENDIX XII.

## MEAN Monthly and Annual Meteorological Results at the Madras Observatory in 1915.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily Range. | Dry Bulb Thermometer. Mean. | Dry Bulb Thermometer. Max. | Dry Bulb Thermometer. Min. | Dry Bulb Thermometer. Range. | Wet Bulb. Mean. | Wet Bulb. Min. | Tension of Vapour. By Blanford's Tables. | Relative Humidity. By Blanford's Tables. | Sun Max in *Vac.* | Min. on Grass. | Wind. Daily Velocity. | Wind. Mean Direction. | Wind. Mean Direction. | Rain. Amount. | Rain. Days. | Clear Sky. | Bright Sunshine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | INCHES. | ° | ° | ° | ° | ° | ° | INCHES. | CENTS. | ° | ° | Miles. | Points. | | INCHES. | No. | CENTS. | HOURS. |
| January ... .. | 30 021 | 0·102 | 76·3 | 84·1 | 69·9 | 14 2 | 71·9 | 68·8 | 0·722 | 80 | 146·5 | 69 3 | 145 | 4 | N.E | 9·61 | 8 | 48 | 197·7 |
| February ... ... | 29·959 | ·116 | 78 5 | 86·7 | 71·1 | 15 6 | 73 2 | 69·7 | ·744 | 77 | 149·7 | 68·2 | 118 | 7 | E. by N. | 0·30 | 1 | 71 | 230·3 |
| March ... ... | ·956 | ·127 | 81·8 | 90 3 | 74·2 | 16·1 | 76 5 | 73·4 | ·840 | 77 | 153·5 | 71·8 | 128 | 11 | S.E. by E | 0·24 | 2 | 78 | 276 3 |
| April ... ... | ·857 | ·125 | 84·7 | 93·5 | 77·5 | 16 0 | 78·9 | 76·3 | ·907 | 76 | 154·8 | 75·6 | 159 | 13 | S.E. by S. | 0 52 | 3 | 84 | 306 2 |
| May ... ... | ·705 | ·124 | 89 6 | 101·8 | 82 6 | 19·2 | 80 2 | 77 0 | ·902 | 65 | 153 2 | 81·3 | 190 | 16 | South. | 0·36 | 2 | 71 | 250·7 |
| June ... ... | ·680 | ·115 | 88·2 | 98·3 | 82·6 | 15·7 | 80 6 | 76·6 | ·893 | 67 | 146 6 | 81·4 | 193 | 17 | S. by W. | 1·31 | 8 | 50 | 153 9 |
| July ... ... | ·722 | ·111 | 84·7 | 94·2 | 78·7 | 15 5 | 78 0 | 74·8 | ·869 | 74 | 144·2 | 77 4 | 171 | 19 | S.W. by S. | 8·80 | 11 | 38 | 131·9 |
| August ... ... | ·733 | ·117 | 85·4 | 95·5 | 79·1 | 16·4 | 78·3 | 75·3 | ·870 | 72 | 148·5 | 77·7 | 151 | 18 | S S.W. | 1·20 | 11 | 44 | 169·2 |
| September ... ... | ·750 | ·137 | 83·8 | 92 9 | 77·4 | 15·5 | 77·8 | 74·6 | ·863 | 76 | 150·9 | 76·1 | 133 | 15 | S. by E | 10·43 | 14 | 39 | 161·1 |
| October ... ... | ·791 | ·128 | 83·5 | 91·9 | 77·0 | 14·9 | 73 0 | 75·4 | ·885 | 78 | 152·5 | 74·8 | 107 | 15 | S. by E. | 2·64 | 10 | 53 | 219·5 |
| November ... ... | ·851 | ·115 | 79·1 | 86·0 | 74·0 | 12 0 | 75·5 | 72·8 | ·834 | 85 | 138 6 | 72·4 | 117 | 4 | N.E | 20 79 | 18 | 41 | 142 8 |
| December ... ... | 988 | ·108 | 76·3 | 84·4 | 69·9 | 14·5 | 70·4 | 67·4 | ·663 | 74 | 145·4 | 67 0 | 169 | 2 | N.N.E. | 0 41 | 4 | 64 | 205·3 |
| Annual ... | 29·834 | 0·119 | 82·7 | 91 6 | 76·2 | 15·4 | 76·6 | 73·5 | 0 833 | 75 | 148·7 | 74 4 | 148 | 12 | S.E. | 56·61 | 92 | 57 | 2,444 9 |

## EXTREME Monthly Meteorological Records at the Madras Observatory in 1915.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry Bulb Thermometer. Highest. | | Dry Bulb Thermometer. Lowest. | | Wet Bulb. Lowest. | | Humidity. Lowest. | | Sun Th. in Vacuo. Highest. | | Grass Therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest Fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | INCHES. | DAY. | INCHES. | DAY. | INCHES. | ° | DAY. | ° | DAY. | ° | DAY. | CENTS. | DAY. | ° | DAY. | ° | DAY. | MILES. | DAY. | MILES. | DAY. | INCHES. | DAY |
| January ... | **30·140** | **18** | 29·891 | 29 | 0·249 | 86·7 | 11 | 65 9 | 9, 18 | 65·1 | 8 | 54 | 8 | 153·2 | 14 | 62 5 | 8, 19 | 215 | 14, 15 | 59 | 28 | **6·69** | **15** |
| February ... | ·073 | 16 | ·843 | 5 | 230 | 90·5 | 5 | 66·3 | 10 | 65·5 | 10 | 52 | 6, 25 | 156 8 | 15 | 63 3 | 10 | 185 | 23 | 75 | 20 | 0·30 | 27 |
| March ... | ·127 | 8 | ·766 | 27 | 361 | 97 4 | 26 | 68·8 | 11 | 68·2 | 11, 12 | 51 | 15 | 160·5 | 21 | 65·4 | 11 | 207 | 27 | 68 | 3 | 0·23 | 3 |
| April ... | 29·993 | 8 | ·710 | 18 | ·283 | 99 8 | 2 | 73·2 | 8 | 72·5 | 8 | 47 | 2 | 163·7 | 16 | 70·4 | 8 | 210 | 3 | **107** | 27 | 0·43 | 29 |
| May ... | ·871 | 26 | **·498** | **9** | ·373 | **107·3** | **12, 20, 21, 23** | 77·4 | 5 | 72·9 | 11 | **23** | **21** | 158·4 | 21 | 76·1 | 5 | 257 | 25 | 93 | 4 | 0·34 | 13 |
| June ... | ·805 | 29 | ·525 | 20 | ·280 | 106·3 | 1 | 76 8 | 24 | 73·2 | 28 | 32 | 20 | 159·6 | 29 | 74·6 | 24 | 263 | **4** | 88 | 22 | 0·58 | 21 |
| July ... | ·863 | 11 | ·540 | 21 | ·323 | 105·8 | 3 | 70·6 | 15 | 70 6 | 15 | 33 | 3 | 155·2 | 3 | 70·8 | 15 | 264 | 3 | 71 | 19 | 3·26 | 15 |
| August ... | ·862 | 12 | ·598 | 1 | ·264 | 100 0 | 22 | 73·7 | 31 | 72 7 | 31 | 43 | 18 | **165·7** | **23** | 72 5 | 31 | 201 | 3 | 80 | 31 | 0·37 | 28 |
| September ... | ·904 | 2 | ·521 | 9 | ·383 | 101·3 | 10 | 72·8 | 17 | 71·4 | 9 | 39 | 10 | 163·5 | 13 | 71 6 | 17 | 224 | 10 | 67 | 23 | 4 15 | 17 |
| October ... | ·912 | 30 | ·638 | 10 | ·274 | 97·7 | 17 | 71·4 | 11 | 71·4 | 11 | 49 | 31 | 161·1 | 18 | 71·4 | 11 | 174 | 28 | 61 | 10 | 1·42 | 11 |
| November ... | 30·024 | 30 | ·554 | 5 | **·470** | 92·7 | 1 | 71·4 | 5, 14 | 69 7 | 5 | 54 | 1 | 156·4 | 18 | 68 1 | 20 | **314** | **21** | **51** | **24** | 3 18 | 21 |
| December ... | ·108 | 11 | ·862 | 6 | ·246 | 86·5 | 16 | **63·8** | **5** | **62·0** | **5** | 46 | 12 | 153·3 | 13 | **60·5** | **5** | 301 | 20 | 80 | 31 | 0·15 | 25 |

# ANNUAL REPORT

OF THE

# DIRECTOR

# KODAIKANAL AND MADRAS OBSERVATORIES

# FOR 1916

MADRAS:
PRINTED BY THE SUPERINTENDENT, GOVERNMENT PRESS.

1917

KODAIKANAL AND MADRAS OBSERVATORIES.

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# REPORT FOR THE YEAR 1916.

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### I.—KODAIKANAL OBSERVATORY.



### II.—MADRAS OBSERVATORY.

# KODAIKANAL AND MADRAS OBSERVATORIES.

## I.—REPORT OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1916.

*Staff.*—The staff of the Observatory on December 31, 1916, was as follows:—

| | |
|---|---|
| Director ... ... ... ... ... | J. Evershed, F.R.S. |
| Assistant Director ... ... ... ... | T. Royds, D.Sc. |
| First Assistant ... ... ... ... | S. Sitarama Ayyar, B.A. |
| Second Assistant ... ... ... ... | G. Nagaraja Ayyar. |
| Third Assistant ... ... ... ... | A. A. Narayana Ayyar, B.A. |
| Fourth Assistant ... ... ... ... | S. Balasundaram Ayyar. |
| Writer ... ... ... ... ... | L. N. Krishnaswami Ayyar. |
| Photographic Assistant ... ... ... | R. Krishna Ayyar. |

MAGNETIC SECTION—

| | |
|---|---|
| Magnetic Observer ... ... ... ... | S. S. Ramaswami Ayyangar, B.A. |
| Magnetic Recorder ... ... ... ... | S. S. Ranga Acharya. |

The Director was on special duty in Kashmir until November 23. The Assistant Director was granted a month's privilege leave from December 4, 1916. The First Assistant was on privilege leave from April 26 to May 20, the Second Assistant from December 6, 1915 to January 15, 1916, the Writer from May 15 to June 15, and the Photographic Assistant from June 13 to August 13. The Bookbinder retired on September 10 after a service of 15 years in this observatory.

The Magnetic Observatory which was working under the Survey of India Department since 1904 was transferred to the Meteorological Department on August 1, 1916.

The First Assistant and Photographic Assistant returned from special duty in Kashmir on March 28.

The subordinate staff consists of a book-binder, an assistant book-binder, a mechanic, six peons (including the peon of the Magnetic Observatory recently transferred from the Survey of India to the Meteorological Department), a boy peon for the dark room and two lascars.

2. *Distribution of work.*—The special distribution of work arranged in the latter half of last year continued till the end of March 1916. The Assistant Director had charge of the two spectroheliographs and of the grating spectrograph until December when the Director took charge of these instruments. The First, Second and Third Assistants were in charge of the work with the Cooke and the Lerebour and Secretan equatorials and also of all astronomical computing, the preparation of the observations for the press and the measurement of spectrum plates. The Third Assistant had charge of the seismometer and clock comparisons, and the meteorological work was done by the Fourth Assistant and the Writer. The Writer was responsible for the accounts, correspondence and all office

records. The Photographic Assistant had charge of the photographic developing, printing, etc.

3. *Buildings and grounds.*—The buildings and grounds and fire lines have been kept in good order. The lathe room was re-roofed during the year.

4. *Instruments.*—The following are the principal instruments belonging to the Observatory, or in use, at the present time :—

Six-inch Cooke equatorial.
Six-inch Lerebour and Secretan equatorial remounted by Grubb, with a five-inch Grubb portrait lens attached. The Lerebour and Secretan object glass has been replaced by a Cooke photo-visual lens of the same aperture and the instrument has been adapted for direct solar photography in addition to visual work.
Spectrograph I.—This with the 11-inch polar siderostat has been dismounted.
Spectrograph II—consisting of a collimator of 7 feet focus and camera of 14 feet focus placed at an angle of 60° with the former. Plane gratings of $3\frac{1}{4}$ inches or 5 inches ruled surface are used, and the slit is provided with various devices for the direct comparison of spectra from different sources, and for rotating the solar image.
Spectroheliograph—with 18-inch siderostat and 12-inch Cooke photo-visual lens of 20 feet focus, by the Cambridge Scientific Instrument Company.
An auxiliary spectroheliograph attached to the above, made in the observatory workshop.
Six-inch transit instrument and barrel chronograph, formerly the property of the Survey of India.
Theodolite, 6-inch—Cooke.
Sextant.
Evershed spectroscope with three prisms, for prominence and sunspot work, by Hilger.
Mean time clock, Kullberg 6326.
Do. Shelton.
Mean time chronometer, Kullberg 6299.
Sidereal chronometer, Kullberg 6134.
Tape chronograph, Fuess.
Two micrometers for measuring spectrum photographs, Hilger.
Hartmann photometer.
Dividing engine, Cambridge Scientific Instrument Company, Limited.
Milne horizontal pendulum seismograph.
Induction coil with necessary adjuncts.
Small polar siderostat.
Universal instrument.
Complete set of meteorological instruments, including a Richard thermograph and barograph and a nephoscope.
A high class screw cutting turning lathe, by Messrs. Cooke & Sons.
Angström pyrheliometer.
An 18-inch concave mirror by Henry of Paris belonging to the Director is mounted in the spectroheliograph room for general spectrum work.

The instruments received from the Takhtasinghji Observatory at Poona include the following :—

Twenty-inch reflecting telescope, by Common.
Six-inch Cooke photo-visual telescope with equatorial mounting.
Two prisms of 6 inches aperture for use with the above.
Twelve-inch Cooke siderostat.
Eight-inch horizontal telescope.
Large grating spectroscope, by Hilger.
An ultra-violet spectrograph, by Grubb.
Sidereal clock, Cooke.
Mean time chronometer, Frodsham No. 3476.
One micrometer for measuring spectrum photographs, Hilger.

The Observatory is greatly indebted to His Highness the Nizam's Government and to the Director of the Nizamiah Observatory for the loan of the following lenses received in January 1915 :—

A 15-inch lens, a 12-inch lens, a 7-inch lens, all by Grubb, and a 4-inch photo-visual lens by Cooke.

The large spectroheliograph for photographing solar images up to $4\frac{1}{2}$ inches diameter erected at Srinagar in 1915 was dismantled in October and the optical parts returned to Kodaikanal.

## OBSERVATIONS.

### (*a*) SOLAR PHYSICS.

5. *Summary of solar observations.*—The following table gives the number of observations made at Kodaikanal during each month of the year :—

| — | January. | February. | March | April. | May. | June. | July. | August. | September. | October. | November. | December. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 31 | 28 | 31 | 30 | 30 | 24 | 30 | 30 | 26 | 26 | 28 | 28 | 342 |
| B | 3 | 2 | 3 | 2 | 6 | ... | 1 | .. | ... | ... | 1 | 3 | 21 |
| C | 31 | 27 | 31 | 28 | 29 | 18 | 26 | 26 | 23 | 23 | 26 | 27 | 315 |
| D | ... | | ... | ... | .. | ... | ... | ... | ... | ... | ... | .. | ... |
| E | 31 | 27 | 31 | 29 | 29 | 20 | 28 | 28 | 25 | 26 | 28 | 27 | 329 |

A = spots and faculae observed. B = spot spectrum observed. C = visual spectroscopic observations made. D = photoheliograms taken. E = spectroheliograms taken.

The year was rather more favourable than usual for spectroscopic observations and prominence records.

At Srinagar 725 Spectroheliograms were obtained on 223 days from January 1st to October 25th, when the instruments were dismantled. The conditions here were extremely favourable from the beginning of May to the end of October. (See section 11).

6. *Photoheliograph.*—This was dismantled in 1915 for work in Kashmir and no direct solar photographs were obtained at Kodaikanal in 1916. The series of daily photographs on a scale of 8 inches to the sun's diameter will be resumed in 1917. At Srinagar 8-inch photographs were obtained on 72 days between January 1 and May 5. After that date the instrument was modified to give a much larger scale, and during the succeeding months special regions of the sun's disc including sunspots were photographed on a scale of 15 inches to the sun's diameter. These plates were obtained on 47 days.

7. *Cambridge spectroheliograph.*—Very satisfactory photographs were obtained with this instrument throughout the year when the definition was good. This is commonly the case between 7–30 and 8-30 a.m. but later in the day good results can very seldom be obtained. Photographs of the sun's disc in "K" light were taken on 329 days and prominence plates on 310 days. Duplicates of the disc plates have been sent to the Cambridge Observatory for measurement.

8. *Grating spectroheliograph.*—Photographs of the sun in H$\alpha$ light were obtained on 258 days. The plates for this work are now sensitized at the observatory by the Photographic Assistant and are superior to the commercial red sensitive plates. A special apparatus has been constructed for drying the plates after sensitizing. The number of absorption markings due to dense prominences on the sun's disc has increased largely and some very remarkable forms were photographed in April.

9. *Grating spectrograph.*—Dr. Royds has employed this instrument for studying the solar displacements, at the centre of the disc and at the limb, of the nickel and titanium lines, using these metals in the electric arc for comparison with the solar lines. The plates obtained have all been measured and reduced and the results were ready for publication at the close of the year. In general these results confirm those obtained with iron, and indicate a low pressure in the reversing layer, and a descending movement of the gases at the centre of the disc. Spectrum plates were also obtained in continuation of the research on the displacements in the sun of lines which are greatly shifted at the negative pole of the arc.

During December the spectrograph was modified for the purpose of photographing the spectrum of Venus. In this work the 15-inch Hyderabad lens after its return from Kashmir, was used to great advantage, and spectra were secured of the planet having a dispersion of 1·4 A per millimeter. Measures of the plates by the positive on negative method will probably yield a fair value of the solar parallax, but the main purpose is the determination of the wave-lengths of some of the solar lines on the side of the sun turned 90 degrees or more from the direction of the earth.

The research on the change of wave-length of the iron lines between the centre of the sun's disc and the limb has been completed and published (Kodaikanal Observatory Bulletin No. XLIX), and the sunspot radial motion plates obtained in 1915 have been measured and the results published in Kodaikanal Observatory Bulletin No. LI.

A number of measures of solar and arc spectra has also been accomplished for the purpose of testing the anomalous dispersion theory. The results show fairly conclusively that anomalous dispersion is not an effective agent in displacing solar lines ('Observatory' Vol. XXXIX, 432).

10. *Six-inch Cooke equatorial and spectroscope.*—This has been employed exclusively for spectrum observations, attention being concentrated on phenomena which cannot readily be photographed, such as metallic prominences, temporary eruptions, and displacements of the hydrogen lines both on the sun's disc and at the limb. The position angles of a few definitely marked prominences are also determined for the purpose of checking the correctness of the angles measured on the photographs; these depend on a fundamental angle computed from the hour angle of the sun at the time a photograph is taken, and errors which would otherwise pass unnoticed may arise in the computation or in the entry of the time.

11. *Kashmir expedition.*—The purpose of this expedition not having been fully accomplished by March 1916 owing to very abnormal weather conditions, the Government of India sanctioned an extension of the work for a further period of seven months at the request of Dr. Walker. The two assistants Messrs. Sitarama Ayyar and Krishna Ayyar who had rendered excellent service during the earlier period returned to Kodaikanal in March, and the Director and Mrs. Evershed continued the work at Srinagar until November 1.

The results obtained during the summer of 1916 amply confirm the original estimates of the general excellence of the climate for solar work. Clear and brilliant skies are the rule during the summer months and the clearness is maintained throughout the day in a large proportion of days, in strong contrast to the conditions prevailing at mountain stations. In more cloudy weather there is a distinct tendency to clear sky along the central axis of the valley while the surrounding hills are thickly covered by clouds.

As regards the winter months the results anticipated in Kodaikanal Observatory Bulletin No. XLII, page 104, were not realized, and during the six months November to April inclusive the conditions as to definition do not appear to differ materially from those found in other localities, that is to say, the definition generally is good in the morning and evening and poor near midday. The four months December to March inclusive must be considered to be considerably less favourable in Kashmir than at Kodaikanal because of the greater prevalence of cloud in Kashmir at that season.

In the month of May in Kashmir a marked improvement occurs in the midday seeing. This appears to coincide with the flooding of the paddy fields, and may also be connected with the growth of crops which then cover the fields and protect the soil from the heating effects of the sun. In the summer months good definition throughout the day is the rule, and superlative definition is of quite frequent occurrence. Very beautiful solar photographs were secured in July and in August under temperature conditions ranging from 80° to 90° in the shade, and good results were also the rule in September and October.

Considerable difficulty was experienced in adapting the instrumental outfit to the high temperature conditions, which produced distortion of the heliostat mirror and large and rapid changes of focus in the lenses. In addition to this, irregular

refraction in the horizontal beam of light between the lenses and the spectroheliograph caused bad definition of the photographs when long exposures were necessary. These troubles were very largely overcome by erecting a movable wet shield over the mirror and a tube of white calico open along the top to protect the beam of light from irregular air currents. This tube was itself protected from the direct sun by a high screen of the same material.

The two principal factors which it is believed conduce to the good definition in Kashmir are the absence of disturbing winds, excluded by the surrounding wall of high mountains ; and the very large areas of wet cultivation which in summer greatly reduce the heating effect of the sun on the soil.

*Summary of Sunspot and Prominence Observations.*

12. *Sunspots.*—The following table shows the monthly numbers of new groups observed at Kodaikanal, the mean daily numbers of spots visible and the distribution between the northern and southern hemispheres :—

| — | January | February. | March. | April. | May | June. | July. | August. | September. | October. | November. | December. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups ... ... | 20 | 26 | 25 | 23 | 22 | 22 | 20 | 19 | 24 | 24 | 22 | 31 | 278 |
| Daily numbers . ... | 3·4 | 4 4 | 3·9 | 3·9 | 4 8 | 3·8 | 4·0 | 2·3 | 2·8 | 3 6 | 4·8 | 5 0 | 3·9 |
| North ... ... ... | 12 | 11 | 14 | 10 | 11 | 12 | 14 | 15 | 16 | 15 | 12 | 16 | 158 |
| South .. ... ... | 8 | 15 | 11 | 13 | 11 | 10 | 6 | 4 | 8 | 9 | 10 | 15 | 120 |
| Equator ... ... | ... | ... | ... | | ... | | . | ... | ... | ... | ... | ... | ... |

The increase in the number of new groups amounts to 40 per cent compared with the previous year but the rate of increase has diminished.

There were ten days in 1915 and five in 1916 on which no spots were recorded.

There was a preponderance of spots in the northern hemisphere as in 1915, and the mean latitude was 16°·0 for northern spots and 18°·4 for southern.

Disturbances in the spot spectrum have been recorded in a large number of cases, as was to be expected in this part of the solar cycle. There were in the whole year 489 cases of C reversals, 51 of $D_3$ darkenings and 145 displacements of the C line.

13. *Prominences.*—The mean daily areas of prominences in square minutes of arc, derived from photographic records made at Kodaikanal and at Srinagar, are as follows :—

| — | North. | South. | Total. |
|---|---|---|---|
| 1916—January to June | 2·06 | 1·77 | 3·83 |
| July to December | 1·98 | 1·65 | 3 58 |

The corresponding totals for the year 1915 were, for the first six months 5·27, and for the second six months 5·29. A reduction of area amounting to about 30 per cent is thus shown.

The mean daily number of prominences recorded during the year is 18·9, a reduction compared with 1915 of under 1 per cent.

The distribution east and west of the sun's axis is interesting as indicating a return to the condition of eastern preponderance. There is only a slight excess of east over west in prominence areas and numbers, the percentage east being 50·6 and 50·5 respectively derived from a total of 6129 prominences. Prominences projected on the disc as absorption markings give percentages east of the central

meridian as 52·2 for areas and 51·5 for numbers, derived from 2618 prominence markings. $D_3$ darkenings also preponderate east of the central meridian and of 489 bright reversals of Hα on the disc 54·3 per cent were east. Only fifty-eight metallic prominences were recorded during the year and these were more frequent on the west limb than on the east. 438 displacements of Hα were observed in the chromosphere and prominences and of these 55 per cent were on the east limb.

On May 26 a very complete record was obtained at Kodaikanal and at Srinagar of an eruptive prominence which rose to the extraordinary height of over 18′, or about half a million miles above the sun—a description of this prominence will be given in Bulletin No. LV.

14. *Solar radiation.*— Observations with the Angstrom pyrheliometer were made near noon in February and March whenever the conditions appeared favourable.

## (b) OTHER OBSERVATIONS.

15. *Time.*—The error of the standard clock is usually determined by reference to the 16-hour signal from the Madras Observatory. This is rendered possible by the courtesy of the Telegraph Department which permits the Madras wire to be joined through to this Observatory. The signal is received with accurac yon most days and all failures are at once reported to the officer in charge of the Trichinopoly division.

16. *Meteorology.*—Eye observations are made at $8^h$, $10^h$ and $16^h$ local mean time as in former years. The Richard thermograph (wet and dry bulb) and barograph, the Beckley anemograph and the sunshine recorder also continue in use. The hourly readings from the barographs, thermographs, and sunshine records are now tabulated at the Calcutta Meteorological Office and the anemograms at the Madras Observatory which also prepares the $8^h$ registers from readings taken here. The preparation of the $10^h$ and $16^h$ registers is done in the Calcutta Meteorological Office. The wind velocity and direction are observed at $8^h$, $10^h$ and $16^h$ as usual from the Robinson anemometer and a wind vane.

Cloud observations with the nephoscope have been made three times a day and the results transmitted monthly to the Agra Aerological Observatory.

*Pressure.*—There was a slight excess of pressure in the months of January, March and April and a defect in all other months, compared with the average for the 11 years 1900—1910. The mean pressure for June was nearly 0·05 inch below the average for that month and for September it was 0·04 inch below normal.

*Temperature.*—The mean temperature for the year was 2° above normal, and an excess over normal is shown in the means for each month. The greatest excess was in March with a mean temperature 3°·2 above normal. The mean sun maximum for the year is also above normal.

*Humidity.*—The mean annual humidity was 70 per cent against a normal of 74 per cent. The greatest defect was in January when the humidity was 44 per cent, the normal value for that month being 64 per cent.

*Rainfall.*—There was a large deficiency in rainfall in the months January to April inclusive and in December. In July there was a very large excess amounting to 7·33 inches, but the year as a whole was in defect by 4·13 inches.

*Wind.*—The average wind velocity for the year was in defect of normal, the mean daily movement being 36 miles less than normal. The defect was found in every month except in May and June when there was a very slight excess. The greatest defect was in July in which month the daily movement was 226 miles against a normal of 427 miles. The greatest deviation from normal in wind direction was in December when the mean direction was south-east by east the normal being north-east.

*Transparency of the atmosphere.*—The transparency of the lower atmosphere as judged by the visibility of the Nilgiris, about 100 miles distant was slightly above normal. The Nilgiris were more or less visible on 112 days.

*Cloud and sunshine.*—The mean amount of clear sky was not very different from the normal except in January when it was 85 per cent against a normal of 64 per cent. There was a large excess in the number of hours of bright sunshine and the excess occurred in every month except June when there was a slight defect. Even in July when the rainfall was unusually heavy there was an excess of 61·6 hours.

17. *Seismology.*—Eighty-one earthquakes were recorded on the Milne horizontal pendulum, as against seventy-two last year. Details of the records are given in Appendix I.

18. *Library.*—One hundred and twenty-four volumes were bound during the year.

19. *Publications.*—Four Bulletins, with the following titles were published during the year :—

No. XLIX.—On the change of wave-length of the iron lines in passing from the centre of the sun's disc to the limb, by J. Evershed, F.R.S., and T. Royds, D.Sc.

No. L.—Summary of prominence observations for the second half of the year 1915, by T. Royds, D.Sc.

No. LI.—New measures of radial motion in sunspots, by J. Evershed, F.R.S.

No. LII.—Summary of prominence observations for the first half of the year 1916, by T. Royds, D.Sc.

In addition the following contributions were made to "The Observatory" by the Director :—

| | | |
|---|---|---|
| Anomalous dispersion in the sun | XXXIX. | 59. |
| Do. do. | XXXIX. | 432. |
| Large prominences | XXXIX. | 392. |

THE OBSERVATORY, KODAIKANAL,
*6th February 1917.*

J. EVERSHED,
*Director, Kodaikanal and Madras Observatories.*

## II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1916.

*Staff.*—The staff at the Observatory on December 31, 1916, was as follows :—

| | |
|---|---|
| Deputy Director .. ... ... ... | R. Ll. Jones. |
| Computer ... ... ... ... ... | S. Solomon Pillai. |
| First Assistant ... ... ... ... ... | C. Chengalvaraya Mudaliyar. |
| Second Assistant ... ... ... ... | E. Ramanujam Pillai. |

Mr. R. Ll. Jones was absent on leave from 22nd May to 26th June 1916, and Mr. James Angus of the Madras Christian College acted for him during his absence. Mr. S. Solomon Pillai was absent on privilege leave from 15th August to 28th October 1916 during which period Mr. C. Chengalvaraya Mudaliyar acted as Computer and Mr. R. K. Sangameswara Ayyar as First Assistant.

2. *Time service.*—The time gun at Fort St. George failed on 30 occasions out of 732, giving a percentage of success of 96. Owing to the shifting of the instruments from the old Port Office to the new Signal Station the dropping of the Semaphore was suspended from 1st January to 22nd February. During the remaining part of the year the Semaphore failed on thirteen occasions; on ten of these it was dropped correctly at 2 P.M. The 4 P.M. roll of signals was sent and received at the Central Telegraph Office, for distribution over India, correctly on every day.

3. *Meteorological observations.*—Meteorological observations were carried on as in former years, and the registers are kept posted up to date. Extra observations were taken for storm warning purposes and telegrams sent to Calcutta on 37 occasions.

4. *Buildings.*—Repairs to the office and quarters were carried out during the year. The construction of the subsoil drain round the Observatory which was undertaken at the end of the previous year was completed during the earlier part of the year. It is too early as yet to say how far it will be effective in stopping the variations in level; but the changes this year have not been so large as in previous years.

5. *Instruments.*—The following is a list of the instruments at the Observatory on 31st December 1916 :—

(a) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton & Simms.
Sidereal clock—Haswall.
 Do. Dent, No. 1408.
 Do. S. Riefler, No. 61.
Mean Time clock—J. H. Agar Baugh, No. 105.
 Do. with galvanometer—Shepherd & Sons.
Meridian circle—Troughton & Simms.
Portable transit instrument—Dolland.
Portable telescope with stand.
Tape chronograph—R. Fuess.
Relay for use with the Chronograph—Siemens.

(b) *Meteorological.*

Richard's Barograph—No. 10, L. Casella.
 Do. Thermograph—No. 29637, L. Casella.
Peander's Self-recording Rain-gauge—No. 116, Lawrence & Mayo.
Beckley's Anemograph—Adie.
Sunshine Recorder—No. 149, L. Casella.
Nephoscope—Mons Jules Daboseq & Ph. Pellin.

Barometer, Fortin's—No. 1771, L. Casella.
Do. do. No. 725, L. Casella (spare).
Do. do. No. 1420, L. Casella.
Dry bulb thermometer—No. 94221, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Wet do. No. 94219, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Dry Maximum thermometer—No. 8581, Negretti and Zambra.
Dry Minimum thermometer—No. 69017, L. Casella.
Wet do. No. 91753, Negretti and Zambra.
Sun Maximum thermometer—No. 127618, Negretti and Zambra.
Grass Minimum thermometer—No. 3377, Negretti and Zambra.
Rain-gauge (8″ diameter) -No. 1042, Negretti and Zambra.
Measure glass for above.
Rain-gauge (5″ diameter).
Measure glass for above.
Stop watch—No. A-3.

The Mean Time Clock by Shepherd & Sons and the Sidereal clock by Haswall were cleaned. The Riefler clock was overhauled and cleaned during the year.

6. *Weather summary.*—The following is a summary of the meteorological conditions at Madras during 1916 :—

*Pressure.*—Pressure was below normal in all other months of the year except in January when the excess was 0·024 inch and the greatest defect was 0·086 inch in September. The highest pressure recorded was 30·149 inches on January 11 and the lowest 29·436 inches on June 13.

*Temperature.*—The mean temperature of the air was above normal throughout the year except in July. The maximum shade temperature was normal in October, below normal in May, July and November and above in all other months. The minimum in shade was below normal in January, March, May, July and December and above normal in the remaining months. The highest shade temperature recorded was 104°·5 on June 7 and the lowest 62°·6 on January 19. The highest sun maximum was 169°·4 on October 3 and the lowest on grass was 58°·4 on January 19.

*Humidity.*—The percentage of humidity was above normal in all months except January, June and December. In these months it was almost normal.

*Wind.*—The wind velocity was in defect almost throughout the year. The highest wind velocity was 369 miles on November 22. The wind direction was nearly normal in all months except October when it was 10 points towards west.

*Cloud.*—The percentage of cloud was above normal in June and below in all other months.

*Sunshine.*—The percentage of bright sunshine was below normal in June, August, September, October and November and above normal in the remaining months. The total number of hours of sunshine during the year was 2,372·1 against 2,444·9 in the previous year.

*Rainfall.*—The rainfall in the year was above normal in June, October and November, and below in all the other months. The greatest excess was 4·30 inches in October and the greatest defect was 2·36 inches in August. The total fall for the year was 46·47 inches on 92 days against an average of 49·02 inches. The greatest fall in the year was 5·09 inches on October 15. The monsoon rainfall from October 15 to the end of the year was 31·62 inches against an average of 26·00 inches.

*Storm.*—A storm of great severity formed in or entered the south-east of the Bay on November 19th and moving slowly westwards crossed the Coromandel Coast to the south of Madras early on the morning of the 23rd. It caused great loss in life and property in the South Arcot District and Pondicherry.

THE OBSERVATORY, MADRAS,
*4th February 1917.*

R. LL. JONES,
*Deputy Director.*

# APPENDIX I.

## STATION—KODAIKANAL OBSERVATORY.

### SEISMIC RECORDS.

$\phi$ = 10° 13′ 50″ $\lambda$ = 77° 28′ 00″ $h$ = 2,343 metres. *Subsoil*—Rock.
*Apparatus*—Milne's Horizontal Pendulum Seismograph.

| 1916. | | | $T_o$ | $\frac{r}{T_o^2}$ | 1916. | | | $T_o$ | $\frac{r}{T_o^2}$ |
|---|---|---|---|---|---|---|---|---|---|
| January | ... | ... | 17·9 | 2·3 | July | ... | ... | 18·2 | 2·5 |
| February | ... | ... | 17 8 | 2·5 | August | .. | . . | 18·0 | 2·4 |
| March | ... | . | 17 9 | 2·4 | September ... | | ... | 18·0 | 2 6 |
| April | .. | .. | 18·2 | 2·6 | October | ... | ... | 18·0 | 2·6 |
| May | ... | ... | 17·9 | 2·5 | November | | ... | 17 8 | 2 5 |
| June | ... | ... | 18·1 | 2·4 | December | . | ... | 18·0 | 2·5 |

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period. (Sec.) | Amplitude ($u$). An. | Ae. | Az. | Distance $\triangle$ (Km.) | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1916. | | | | | | | | | | |
| 1 | January* 1 ... | ... | | ... | | ... | ... | ... | ... | ... | No P. Ts. |
| | | iL | 13 | 32 | 36 | ... | .. | | ... | ... | |
| | | M | 14 | 13 | 12 | ... | ... | 830 | ... | ... | |
| | | F | 17 | 26 | 00 | ... | ... | ... | ... | ... | |
| 2 | 13 ... | eP | 6 | 27 | 48 | ... | .. | ... | ... | .. | Overlapping. |
| | | iL | 6 | 48 | 06 | ... | ... | ... | ... | ... | |
| | | M | 6 | 49 | 42 | ... | ... | 50 | .. | .. | |
| | | F | | ? | | .. | ... | | . | ... | |
| 3 | 13 .. | iP | 8 | 30 | 48 | ... | ... | .. | ... | ... | |
| | | iL | 8 | 38 | 42 | ... | ... | ... | | ... | |
| | | M | 8 | 55 | 00 | .. | .. | 65 | ... | ... | |
| | | F | 12 | 21 | 48 | ... | ... | . | ... | ... | |
| 4 | 19 ... | eP | 19 | 18 | 42 | ... | ... | . | .. | ... | Widening of line. |
| | | F | 20 | 29 | 30 | ... | ... | . | ... | ... | |
| 5 | 24 .. | iP | 7 | 09 | 36 | ... | | ... | ... | ... | |
| | | iL | 7 | 13 | 48 | ... | . | .. | ... | ... | |
| | | M | 7 | 35 | 54 | .. | ... | 490 | ... | ... | |
| | | F | 8 | 55 | 30 | ... | .. | ... | ... | ... | |
| 6 | 26 ... | eP | 8 | 13 | 18 | ... | ... | ... | . | ... | Widening of line. |
| | | F | 8 | 38 | 12 | ... | ... | ... | ... | ... | |
| 7 | 26 ... | eP | 13 | 23 | 00 | . | ... | ... | ... | ... | Widening of line. |
| | | F | 14 | 00 | 54 | ... | ... | ... | ... | ... | |
| 8 | 30 ... | eP | 21 | 39 | 48 | .. | .. | . | ... | . | Widening of line. |
| | | F | 22 | 04 | 00 | ... | ... | .. | ... | . | |
| 9 | 31 . | eP | 18 | 40 | 18 | ... | ... | ... | ... | ... | |
| | | L | | ... | | | ... | . | ... | | |
| | | M | 19 | 29 | 12 | . | | 50 | ... | ... | |
| | | F | 20 | 10 | 54 | ... | ... | .. | ... | ... | |
| 10 | February 1 . | eP | 7 | 46 | 12 | ... | . . | ... | ... | . | |
| | | iL | 7 | 57 | 48 | ... | ... | .. | | . | |
| | | M | 8 | 12 | 48 | ... | ... | 650 | ... | ... | |
| | | F | 10 | 45 | 24 | ... | ... | ... | ... | ... | |
| 11 | 6 ... | iP | 22 | 15 | 48 | ... | ... | .. | . | .. | |
| | | iL | 22 | 43 | 06 | | .. | ... | | ... | |
| | | M | 22 | 51 | 54 | ... | .. | 250 | ... | .. | |
| | | F | 23 | 38 | 48 | | ... | ... | ... | ... | |
| 12 | 10 ... | eP | 2 | 15 | 36 | .. | ... | | ... | .. | |
| | | iL | 2 | 18 | 24 | ... | ... | | ... | ... | |
| | | M | 2 | 21 | 48 | | ... | 40 | ... | ... | |
| | | F | 2 | 36 | 24 | | . | .. | | ... | |
| 13 | 14 ... | iP | 10 | 17 | 54 | . | ... | . | ... | ... | |
| | | eL | 10 | 20 | 00 | ... | | ... | ... | ... | |
| | | M | 10 | 24 | 06 | .. | .. | 50 | ... | ... | |
| | | F | 11 | 13 | 18 | ... | ... | ... | ... | ... | |
| 14 | 14 ... | eP | 17 | 49 | 48 | ... | ... | .. | ... | ... | |
| | | iL | 17 | 54 | 48 | ... | ... | ... | | ... | |
| | | M | 17 | 57 | 18 | ... | ... | 150 | ... | . | |
| | | F | 18 | 29 | 36 | ... | ... | . | ... | ... | |
| 15 | 15 ... | eP | 12 | 31 | 48 | ... | .. | ... | ... | ... | |
| | | iL | 12 | 39 | 00 | ... | ... | ... | ... | ... | |
| | | M | 12 | 41 | 06 | ... | ... | 80 | ... | .. | |
| | | F | 13 | 13 | 00 | ... | . | ... | | ... | |

* The instrument was not working satisfactorily during the month. From January 13th to February 5th it was under repairs and during this period record was obtained only on January 17th.

Kodaikanal Observatory, Seismic Records—*cont.*

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period (Sec.). | Amplitude (u). An. | Ae. | Az. | Distance △ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1916. | | | | | | | | | | |
| 16 | February 20 ... | iP | 18 | 12 | 24 | ... | ... | ... | ... | ... | |
| | | iL | 18 | 44 | 24 | ... | ... | ... | | | |
| | | M | 18 | 53 | 42 | ... | ... | 160 | ... | ... | |
| | | F | 20 | 38 | 00 | ... | ... | ... | | | |
| 17 | 21 ... | iP | 14 | 02 | 36 | | ... | | ... | ... | Widening of line. |
| | | F | 14 | 19 | 42 | ... | ... | ... | ... | ... | |
| 18 | 28 ... | eP | 20 | 45 | 24 | | | ... | ... | ... | |
| | | iL | 21 | 44 | 42 | ... | ... | ... | | ... | |
| | | M | 22 | 01 | 42 | ... | ... | 350 | | ... | |
| | | F | 23 | 20 | 30 | ... | | ... | ... | ... | |
| 19 | March 4 ... | eP | 7 | 48 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 8 | 39 | 48 | ... | | ... | ... | ... | |
| 20 | 26 ... | eP | 0 | 08 | 00 | ... | ... | ... | ... | | Widening of line. |
| | | F | 0 | 46 | 24 | ... | | ... | ... | ... | |
| 21 | 26 ... | P | | ... | | | ... | ... | | ... | |
| | | iL | 2 | 19 | 24 | ... | ... | | ... | | |
| | | M | 2 | 20 | 30 | ... | | 50 | | ... | |
| | | F | 2 | 28 | 12 | | ... | | ... | | |
| 22 | April 5 ... | eP | 21 | 20 | 30 | ... | ... | ... | ... | ... | |
| | | eL | 21 | 25 | 36 | | | ... | ... | ... | |
| | | M | 21 | 31 | 30 | ... | ... | 50 | ... | ... | |
| | | F | 21 | 51 | 00 | ... | | ... | | ... | |
| 23 | 7 ... | iP | 9 | 41 | 36 | ... | ... | | ... | ... | |
| | | iL | 9 | 41 | 48 | | ... | ... | ... | | |
| | | M | 9 | 51 | 36 | ... | ... | 1,120 | ... | ... | |
| | | F | 11 | 53 | 36 | ... | ... | ... | ... | | |
| 24 | 7 ... | eP | 14 | 48 | 12 | ... | ... | ... | ... | | |
| | | eL | 14 | 56 | 54 | ... | | ... | ... | ... | |
| | | M | 14 | 58 | 42 | ... | ... | 40 | ... | ... | |
| | | F | 15 | 06 | 54 | | | ... | | ... | |
| 25 | 14 ... | eP | 17 | 50 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 18 | 06 | 24 | ... | ... | ... | ... | ... | |
| 26 | 15 | P | | ? | | ... | ... | ... | ... | ... | Beginning lost in hour mark at $9^h\,30^m$. |
| | | eL | 9 | 34 | 36 | ... | ... | ... | ... | ... | |
| | | M | 9 | 35 | 30 | ... | ... | 60 | ... | ... | |
| | | F | 9 | 56 | 48 | ... | ... | ... | ... | ... | |
| 27 | 15 ... | eP | 12 | 38 | 30 | ... | | ... | ... | ... | |
| | | iL | 12 | 42 | 24 | ... | | ... | ... | ... | |
| | | M | 12 | 47 | 30 | ... | ... | 420 | ... | ... | |
| | | F | 14 | 23 | 36 | ... | | | ... | ... | |
| 28 | 15 ... | eP | 15 | 08 | 36 | ... | ... | ... | ... | ... | |
| | | iL | 15 | 19 | 24 | ... | ... | ... | ... | ... | |
| | | M | 15 | 20 | 00 | ... | ... | 60 | ... | ... | |
| | | F | 15 | 52 | 42 | ... | | ... | ... | ... | |
| 29 | 18 ... | eP | 4 | 25 | 06 | ... | ... | | ... | ... | |
| | | iL | 4 | 26 | 42 | ... | ... | ... | ... | ... | |
| | | M | 4 | 27 | 24 | ... | ... | 50 | ... | ... | |
| | | F | 5 | 37 | 12 | ... | ... | ... | ... | ... | |
| 30 | 21 ... | eP | 11 | 44 | 48 | ... | ... | | ... | ... | |
| | | iL | 11 | 46 | 30 | ... | ... | ... | ... | ... | |
| | | M | 11 | 47 | 30 | ... | ... | 100 | ... | ... | |
| | | F | 13 | 09 | 54 | ... | | ... | ... | ... | |
| 31 | 21 ... | eP | 14 | 05 | 54 | ... | | | | ... | |
| | | iL | 14 | 11 | 00 | ... | ... | ... | ... | ... | |
| | | M | 14 | 12 | 18 | ... | ... | 50 | ... | ... | |
| | | F | 14 | 37 | 42 | ... | ... | ... | ... | ... | |
| 32 | 24 ... | eP | 8 | 25 | 24 | ... | ... | ... | ... | ... | |
| | | iL | 8 | 47 | 00 | ... | ... | ... | ... | ... | |
| | | M | 8 | 47 | 30 | | ... | 50 | ... | ... | |
| | | F | | ? | | ... | ... | ... | ... | ... | |
| 33 | 24 ... | P | | ? | | ... | ... | ... | | ... | Overlapping. |
| | | iL | 9 | 36 | 42 | ... | ... | | ... | ... | |
| | | M | 9 | 41 | 30 | ... | ... | 200 | ... | ... | |
| | | F | 10 | 35 | 24 | ... | ... | | ... | ... | |
| 34 | 26 ... | P | | ? | | ... | ... | ... | ... | ... | Instrument examined at $3^h\,38^m$. |
| | | L | | ? | | ... | ... | ... | ... | ... | |
| | | M | 4 | 01 | 24 | | ... | 120 | ... | ... | |
| | | F | 4 | 35 | 42 | ... | ... | ... | ... | ... | |
| 35 | May 9 ... | P | | ... | | | ... | ... | ... | ... | No P. Ts. |
| | | iL | 14 | 40 | 18 | ... | ... | ... | ... | ... | |
| | | M | 14 | 43 | 18 | ... | ... | 580 | ... | ... | |
| | | F | 15 | 22 | 18 | ... | ... | ... | ... | ... | |
| 36 | 15 ... | eP | 22 | 38 | 48 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 22 | 47 | 30 | ... | ... | ... | ... | ... | |

Kodaikanal Observatory, Seismic Records—*cont.*

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period (Sec.). | Amplitude ($u$). An. | Ae. | Az. | Distance $\triangle$ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1916. | | | | | | | | | | |
| 37 | May 23 ... | eP | 22 | 54 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 23 | 06 | 54 | ... | ... | .. | .. | ... | |
| 38 | June 14 .. | eP | 14 | 19 | 24 | ... | ... | ... | . | ... | |
| | | eL | 14 | 20 | 12 | ... | ... | ... | | ... | |
| | | M | 14 | 21 | 12 | ... | ... | 50 | ... | .. | |
| | | F | 14 | 39 | 18 | ... | ... | ... | ... | .. | |
| 39 | 15 ... | eP | 11 | 32 | 00 | ... | . | ... | ... | ... | |
| | | eL | 11 | 39 | 48 | .. | ... | .. | . | .. | |
| | | M | 11 | 43 | 54 | ... | ... | 110 | ... | ... | |
| | | F | 12 | 40 | 00 | .. | ... | ... | ... | ... | |
| 40 | 21 ... | eP | 20 | 09 | 36 | ... | ... | ... | . | ... | |
| | | iL | 20 | 09 | 48 | ... | ... | ... | . | ... | |
| | | M | 20 | 10 | 36 | ... | ... | 110 | . | . | |
| | | F | 20 | 23 | 36 | . | ... | .. | ... | ... | |
| 41 | 21 ... | eP | 21 | 53 | 36 | .. | . | ... | .. | .. | |
| | | eL | 22 | 03 | 48 | | .. | ... | .. | ... | |
| | | M | 22 | 10 | 00 | .. | .. | 50 | ... | ... | |
| | | F | 23 | 57 | 42 | .. | ... | ... | ... | ... | |
| 42 | 30 ... | eP | 4 | 20 | 12? | ... | .. | . | ... | .. | Confused by air tremors. |
| | | eL | 4 | 32 | 48 | .. | ... | ... | ... | ... | |
| | | M | 4 | 33 | 48 | ... | ... | 120 | ... | ... | |
| | | F | 5 | 22 | 48? | ... | ... | ... | ... | ... | |
| 43 | July 13 ... | eP | 15 | 26 | 12 | . | ... | ... | ... | ... | Widening of line. |
| | | F | 15 | 42 | 42 | .. | ... | ... | ... | .. | |
| 44 | 27 ... | eP | 11 | 57 | 06 | ... | ... | ... | ... | ... | |
| | | iL | 11 | 58 | 06 | ... | ... | ... | ... | ... | |
| | | M | 12 | 07 | 00 | ... | ... | 80 | ... | ... | |
| | | F | 12 | 24 | 06 | ... | .. | ... | ... | ... | |
| 45 | August 8 .. | eP | 1 | 42 | 06 | ... | ... | ... | ... | ... | |
| | | iL | 1 | 51 | 00 | ... | ... | ... | ... | ... | |
| | | M | 1 | 52 | 12 | ... | ... | 100 | ... | ... | |
| | | F | 2 | 55 | 42 | .. | ... | ... | ... | ... | |
| 46 | 8 ... | eP | 5 | 04 | 36 | ... | ... | .. | ... | ... | Widening of line. |
| | | F | 5 | 20 | 18 | ... | ... | ... | ... | ... | |
| 47 | 25 ... | eP | 10 | 15 | 30 | ... | ... | ... | .. | ... | |
| | | eL | 11 | 02 | 18 | ... | ... | ... | ... | ... | |
| | | M | 11 | 13 | 18 | .. | ... | 110 | ... | ... | |
| | | F | 11 | 55 | 06 | ... | ... | ... | ... | ... | |
| 48 | 28 ... | iP | 6 | 44 | 36 | ... | ... | ... | ... | ... | |
| | | iL | 6 | 47 | 36 | ... | ... | ... | ... | ... | |
| | | M | 6 | 52 | 00 | | ... | 900 | ... | ... | |
| | | F | | ... | | ... | ... | .. | ... | ... | |
| 49 | 28 ... | P | | ... | | .. | ... | | ... | ... | |
| | | iL | 7 | 55 | 48 | . | . | ... | ... | ... | |
| | | M | 7 | 57 | 18 | ... | ... | 22 | ... | ... | |
| | | F | 8 | 52 | 00 | ... | ... | ... | ... | ... | |
| 50 | September 11 ... | eP | 9 | 36 | 06 | ... | ... | ... | ... | .. | |
| | | iL | 9 | 44 | 00 | ... | ... | ... | .. | .. | |
| | | M | 9 | 45 | 06 | ... | ... | 100 | .. | ... | |
| | | F | 11 | 07 | 00 | ... | ... | ... | ... | ... | |
| 51 | 15 ... | eP | 7 | 12 | 00 | ... | ... | ... | . | ... | |
| | | iL | 7 | 20 | 00 | .. | ... | ... | .. | ... | |
| | | M | 7 | 21 | 48 | .. | ... | 50 | ... | ... | |
| | | F | 8 | 19 | 42 | ... | ... | ... | ... | ... | |
| 52 | 29 ... | eP | 20 | 24 | 06 | ... | ... | ... | .. | ... | Widening of line. |
| | | F | 20 | 41 | 30 | . | .. | ... | ... | ... | |
| 53 | October 3 ... | eP | 1 | 49 | 54 | ... | .. | | . | ... | |
| | | eL | 1 | 59 | 36 | ... | ... | ... | . | ... | |
| | | M | 2 | 12 | 12 | | ... | 50 | .. | ... | Overlapping. |
| | | F | | ... | | ... | .. | ... | ... | . | |
| 54 | 3 ... | P | | ... | | | ... | ... | | ... | |
| | | iL | 2 | 48 | 36 | ... | .. | ... | ... | ... | |
| | | M | 2 | 54 | 18 | . | ... | 150 | | ... | |
| | | F | 3 | 49 | 00? | ... | ... | ... | ... | ... | |
| 55 | 14 ... | P | | ... | | ... | | ... | . | ... | No P. Ts. |
| | | iL | 19 | 57 | 36 | ... | ... | ... | ... | ... | |
| | | M | 19 | 58 | 18 | ... | ... | 200 | ... | ... | |
| | | F | 20 | 18 | 30 | ... | ... | .. | ... | ... | |
| 56 | 20 ... | eP | 17 | 24 | 54 | ... | ... | ... | . | .. | Widening of line. |
| | | F | 19 | 40 | 12 | ... | ... | ... | ... | ... | |
| 57 | 21 ... | eP | 19 | 30 | 00? | ... | ... | ... | ... | ... | Hour mark at $19^h\ 30^m$. |
| | | iL | 19 | 34 | 36 | ... | .. | ... | ... | | |
| | | M | 19 | 36 | 54 | ... | ... | 190 | ... | .. | |
| | | F | 20 | 18 | 48 | ... | ... | ... | ... | ... | |

Kodaikanal Observatory, Seismic Records—*cont.*

| No. | Date | | Phase. | Time G.M.T. | | | Period (Sec.). | Amplitude ($u$). | | | Distance △ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | An. | Ae. | Az. | | |
| | 1916. | | | H. | M. | S. | | | | | | |
| 58 | October | 31 .. | eP | 1 | 09 | 42 | ... | ... | ... | . | ... | |
| | | | eL | 1 | 15 | 48 | . | | ... | | | |
| | | | M | 1 | 18 | 00 | | | 50 | ... | ... | |
| | | | F | 1 | 35 | 36 | ... | | . | ... | ... | |
| 59 | | 31 | eP | 15 | 43 | 18 | .. | | | ... | . | |
| | | | iL | 15 | 52 | 42 | ... | ... | .. | ... | ... | |
| | | | M | 16 | 18 | 48 | | ... | 270 | | ... | |
| | | | F | 18 | 26 | 12 | ... | . | . | .. | .. | |
| 60 | November | 4 .. | eP | 2 | 36 | 09 | .. | .. | .. | | . | |
| | | | eL | 2 | 40 | 00 | .. | . | ... | ... | .. | |
| | | | M | 2 | 43 | 00 | ... | . | 40 | ... | | |
| | | | F | 2 | 50 | 02 | ... | | .. | . | ... | |
| 61 | | 11 . | eP | 14 | 16 | 05 | .. | .. | . | . | | |
| | | | eL | 14 | 20 | 00 | .. | . | .. | | .. | |
| | | | M | 14 | 23 | 06 | .. | ... | 80 | .. | .. | |
| | | | F | 14 | 36 | 09 | ... | ... | ... | | ... | |
| 62 | | 11 ... | eP | 16 | 03 | 07 | .. | ... | .. | ... | ... | |
| | | | eL | 16 | 07 | 03 | ... | ... | | ... | ... | |
| | | | M | 16 | 11 | 09 | ... | ... | 70 | ... | ... | |
| | | | F | 16 | 24 | 01 | ... | ... | ... | ... | ... | |
| 63 | | 13 ... | eP | 12 | 44 | 54 | .. | ... | . | ... | .. | |
| | | | F | 12 | 55 | 36 | ... | ... | ... | .. | .. | Widening of line. |
| 64 | | 14 .. | eP | 22 | 51 | 12 | ... | .. | . | ... | ... | |
| | | | eL | 22 | 59 | 24 | ... | ... | ... | .. | ... | |
| | | | M | 23 | 00 | 54 | . | . | 80 | ... | ... | |
| | | | F | 23 | 16 | 30 | ... | ... | ... | ... | . | |
| 65 | | 18 ... | eP | 12 | 40 | 30 | ... | ... | | . | ... | |
| | | | F | 12 | 56 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| 66 | | 21 .. | eP | 7 | 53 | 12 | ... | ... | ... | . | ... | |
| | | | eL | 8 | 04 | 42 | ... | ... | | ... | ... | |
| | | | M | 8 | 18 | 48 | ... | . | 50 | ... | ... | |
| | | | F | 8 | 26 | 24 | ... | ... | .. | .. | ... | |
| 67 | | 22 .. | eP | 20 | 03 | 18 | ... | ... | ... | . . | ... | |
| | | | eL | 20 | 06 | 54 | ... | | ... | ... | ... | |
| | | | M | 20 | 09 | 12 | ... | | 40 | .. | . | |
| | | | F | 20 | 20 | 48 | ... | ... | ... | .. | ... | |
| 68 | | 24 ... | eP | 4 | 47 | 36 | .. | | | . | . | |
| | | | F | 4 | 49 | 42 | ... | ... | .. | .. | ... | Widening of line. |
| 69 | | 24 .. | eP | 12 | 57 | 30 | .. | ... | | .. | ... | |
| | | | F | 13 | 08 | 36 | .. | ... | ... | ... | ... | Widening of line. |
| 70 | | 30 . | eP | 4 | 40 | 18 | . | . | ... | . | ... | |
| | | | F | 5 | 09 | 30 | .. | ... | ... | ... | ... | Widening of line. |
| 71 | December | 1 .. | eP | 21 | 46 | 00 | ... | ... | .. | ... | ... | |
| | | | F | 21 | 57 | 24 | ... | .. | . | | ... | Widening of line. |
| 72 | | 2 .. | eP | 13 | 11 | 54 | .. | ... | .. | ... | ... | |
| | | | eL | 13 | 14 | 24 | . | .. | ... | .. | ... | |
| | | | M | 13 | 17 | 30 | ... | ... | 30 | . | ... | |
| | | | F | 13 | 24 | 06 | . . | ... | ... | ... | ... | |
| 73 | | 3 . | P | | ... | | . | . | ... | ... | ... | |
| | | | iL | 8 | 47 | 24 | ... | ... | .. | | ... | |
| | | | M | 8 | 47 | 24 | ... | ... | 40 | | ... | |
| | | | F | 8 | 51 | 30 | . . | | | . . | ... | |
| 74 | | 5 . | eP | 21 | 44 | 30 | ... | | | . . | ... | |
| | | | F | 21 | 56 | 24 | ... | - | | | ... | Widening of line. |
| 75 | | 9 ... | eP | 0 | 44 | 30 | ... | | | ... | .. | |
| | | | F | 0 | 48 | 36 | ... | | ... | | ... | Widening of line. |
| 76 | | 14 ... | eP | 17 | 41 | 00 | ... | . | | .. | .. | |
| | | | F | 18 | 08 | 00 | ... | . | .. | ... | ... | Widening of line. |
| 77 | | 23 ... | eP | 10 | 05 | 42 | ... | ... | . | ... | ... | |
| | | | eL | 10 | 43 | 00 | ... | ... | . | | ... | |
| | | | M | 10 | 55 | 42 | ... | ... | 60 | ... | ... | |
| | | | F | 11 | 29 | 30 | ... | ... | ... | .. | .. | |
| 78 | | 24 | P | | .. | | ... | .. | ... | ... | . | |
| | | | eL | 8 | 03 | 24 | ... | ... | ... | ... | ... | |
| | | | M | 8 | 04 | 54 | ... | ... | 50 | ... | ... | |
| | | | F | 8 | 12 | 24 | ... | | ... | . . | ... | |
| 79 | | 26 ... | eP | 4 | 08 | 06 | ... | ... | . | ... | ... | |
| | | | F | 4 | 38 | 06 | ... | | ... | ... | ... | Widening of line. |
| 80 | | 26 ... | eP | 20 | 34 | 18 | ... | ... | ... | ... | ... | |
| | | | F | 21 | 05 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| 81 | | 27 ... | eP | 22 | 08 | 36 | ... | ... | ... | ... | ... | |
| | | | F | 22 | 29 | 00 | ... | ... | ... | ... | ... | Widening of line. |

# APPENDIX II.

Latitude 10° 13′ 50″ N.

Longitude $5^h$ $9^m$ $52^s$ E.

Height of Barometer cistern above mean sea level 7,688 feet.

## MEAN Monthly and Annual Meteorological Results at the Kodaikanal Observatory in 1916.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily Range. | Dry Bulb Thermometer. Mean. | Dry Bulb Thermometer. Max. | Dry Bulb Thermometer. Min | Dry Bulb Thermometer. Range. | Wet Bulb. Mean. | Wet Bulb. Min. | Tension of Vapour. By Simpson's Tables. | Relative Humidity. By Simpson's Tables. | Sun Max. in Vac. | Min. on Grass | Wind. Daily Velocity. | Wind. Mean Direction. | Wind. Mean Direction. | Rain. Amount. | Rain. Days. | Clear Sky. | Bright Sun-shine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Inches. | ° | ° | ° | ° | ° | ° | Inches. | Cents. | ° | ° | Miles. | Points. | Points. | Inches. | No. | Cents. | Hours. |
| January | 22·864 | 0·064 | 56 5 | 67·5 | 45·5 | 22 0 | 45·0 | 36·6 | 0·192 | 44 | 125·4 | 34·8 | 292 | 3 | N.E. by N. | ... | ... | 85 | 318·0 |
| February | ·835 | ·069 | 57·2 | 66 6 | 47·7 | 18 9 | 47·6 | 41·2 | ·250 | 57 | 128 0 | 36·6 | 249 | 6 | E.N.E. | 0·06 | | 68 | 245·1 |
| March | ·859 | ·058 | 61·0 | 70·9 | 51·0 | 19 9 | 49·5 | 43·6 | ·246 | 49 | 136·3 | 41·3 | 299 | 3 | N.E. by N. | 0·72 | 1 | 76 | 293·9 |
| April | ·843 | ·062 | 62·8 | 71·8 | 53·9 | 17·9 | 53·3 | 48 0 | ·323 | 60 | 132·0 | 46·0 | 273 | 5 | N.E. by E. | 1·86 | 5 | 59 | 272·3 |
| May | ·793 | ·059 | 62·4 | 70·1 | 54 6 | 15 5 | 55·5 | 50·2 | ·381 | 70 | 135·3 | 48·4 | 259 | 5 | N.E. by E. | 7·41 | 11 | 53 | 251·8 |
| June | ·720 | ·052 | 58·2 | 63·3 | 53·0 | 10·3 | 53·9 | 49·8 | ·381 | 81 | 119 4 | 49·2 | 376 | 23 | W by S. | 2·30 | 7 | 19 | 107·6 |
| July | ·738 | ·054 | 59·1 | 65 2 | 53·1 | 12·1 | 55·1 | 50·8 | ·404 | 83 | 128·6 | 48·5 | 226 | 22 | W.S.W. | 11 52 | 16 | 28 | 164·2 |
| August | ·769 | ·061 | 58·1 | 63·9 | 52·2 | 11·7 | 54·3 | 49 7 | ·391 | 83 | 126·0 | 48·4 | 284 | 21 | S.W. by W. | 8·53 | 14 | 26 | 158·2 |
| September | ·745 | ·071 | 57 9 | 63·4 | 52·5 | 10 9 | 54·2 | 49·7 | ·392 | 83 | 123 9 | 48 7 | 293 | 23 | W. by S. | 8 35 | 9 | 25 | 136·1 |
| October | ·777 | ·069 | 57·4 | 63·0 | 51 7 | 11·3 | 53·7 | 49·3 | ·383 | 83 | 119·0 | 47·5 | 208 | 27 | N.W. by W. | 6·97 | 11 | 26 | 145·1 |
| November | ·804 | ·062 | 56·2 | 63·3 | 49·2 | 14·1 | 51·9 | 45·9 | ·354 | 79 | 121·2 | 44 5 | 233 | 4 | N.E. | 6·48 | 10 | 38 | 188·7 |
| December | ·798 | ·058 | 53·4 | 61 4 | 45·4 | 16·0 | 47·7 | 41·0 | ·286 | 71 | 117·2 | 45·2 | 246 | 11 | S.E. by E. | 1·22 | 4 | 52 | 220·2 |
| Annual | 22·795 | 0·062 | 58·4 | 65·9 | 50·8 | 15·0 | 51·8 | 46·3 | 0·332 | 70 | 126 0 | 44·9 | 270 | 31 | N. by W. | 55·42 | 88 | 46 | 2,501·2 |

## EXTREME Monthly Meteorological Records at the Kodaikanal Observatory in 1916.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry Bulb Thermometer. Highest. | | Dry Bulb Thermometer. Lowest. | | Wet Bulb. Lowest. | | Humidity. Lowest. | | Sun Th. in Vacuo. Highest | | Grass Therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest Fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Day. | Inches. | Day. | Inches. | ° | Day. | ° | Day. | ° | Day. | Cents. | Day. | ° | Day. | ° | Day. | Miles | Day. | Miles. | Day. | Inches. | Day. |
| January | 22·940 | 15 | 22·790 | 7 | 0·150 | **76·3** | **25** | 40·4 | 11 | 32·5 | 29 | **5** | **26** | 132·4 | 25 | **24 1** | **20** | 502 | 13 | 178 | 9 | ... | ... |
| February | ·926 | 29 | ·745 | 8 | ·181 | 72·8 | 1,23 | **41·6** | 4 | **31·3** | **5** | 16 | 2 | 140·7 | 18 | 26·4 | 5 | 544 | 26 | **71** | **6** | 0·04 | 16 |
| March | **·941** | **17** | ·789 | 11 | ·152 | 75·4 | 29 | 44·7 | 10 | 35·2 | 11 | 11 | 11 | 146 9 | 20 | 34·1 | 3 | 445 | 24 | 165 | 12 | 0·71 | 26 |
| April | ·927 | 7 | ·766 | 21 | ·161 | 75·6 | 24 | 50·5 | 14 | 40·3 | 2 | 20 | 2 | 145 9 | 17 | 36·5 | 2 | 344 | 24 | 185 | 7 | 0·94 | 5 |
| May | ·903 | 7 | ·669 | 22 | ·234 | 73·8 | 1 | 52·0 | 19 | 43 4 | 12 | 34 | 12 | 143·9 | 12 | 41·0 | 6 | 393 | 20 | 150 | 28 | 1·82 | 23 |
| June | 842 | 30 | **·616** | **13** | ·226 | 67·9 | 30 | 50·7 | 25 | 44·9 | 29 | 37 | 30 | 141·5 | 17 | 43·1 | 30 | 548 | **3** | 81 | 30 | 0 43 | 4 |
| July | ·828 | 14 | ·635 | 21 | ·193 | 68·0 | 5 | 50·0 | 1,2 | 42·1 | 1 | 39 | 2 | 14[illegible]·6 | 5 | 35·8 | 2 | 497 | 31 | 96 | 2 | **2·37** | **17** |
| August | ·858 | 9 | ·683 | 1 | ·175 | 68 2 | 25 | 50·8 | 5,15 | 45 6 | 17 | 61 | 8,17 | **150 0** | **24** | 44·2 | 17 | 584 | 2 | 98 | 10 | 1 81 | 24 |
| September | ·809 | 5,23 | ·654 | 10 | ·155 | 67·1 | 26 | 48·7 | 29 | 40·7 | 29 | 48 | 28 | 141·0 | 25 | 39 0 | 29 | **606** | **20** | 130 | 15 | 2·27 | 2 |
| October | ·874 | 10 | ·651 | 17 | ·223 | 68 2 | 4 | 47·6 | 22 | 41·6 | 22 | 36 | 30 | 139 0 | 1 | 39·1 | 1 | 369 | 16 | 97 | 5 | 1·57 | 26 |
| November | ·906 | 14 | ·679 | 2 | ·227 | 67·7 | 3 | 44·2 | 27 | 36·1 | 22 | 21 | 22 | 137·9 | 5 | 38·1 | 21 | 480 | 22 | 102 | 5 | 1·72 | 15 |
| December | ·860 | 14 | ·724 | 27 | ·136 | 69·6 | 18 | **40 3** | **23** | 33·5 | 21 | **17** | 18 | 140·9 | 5 | 27·1 | 22 | 416 | 15 | 97 | 22 | 0·67 | 9 |

# APPENDIX III.

KODAIKANAL mean hourly wind velocity for the year 1916.

| Month. | Hours. 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 14 | 14 | 14 | 14 | 15 | 14 | 14 | 13 | 13 | 15 | 14 | 14 | 12 | 12 | 10 | 9 | 7 | 8 | 11 | 12 | 13 | 14 | 14 | 15 |
| February | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 13 | 16 | 15 | 14 | 13 | 11 | 10 | 9 | 7 | 6 | 6 | 6 | 7 | 8 | 9 | 10 |
| March | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 14 | 16 | 19 | 16 | 15 | 16 | 13 | 11 | 11 | 9 | 8 | 7 | 8 | 8 | 9 | 11 | 12 |
| April | 10 | 11 | 11 | 11 | 11 | 11 | 12 | 11 | 13 | 15 | 15 | 13 | 13 | 12 | 11 | 10 | 10 | 9 | 10 | 11 | 11 | 10 | 10 | 10 |
| May | 11 | 10 | 11 | 11 | 10 | 10 | 9 | 10 | 11 | 12 | 11 | 11 | 11 | 11 | 11 | 11 | 10 | 9 | 9 | 11 | 11 | 12 | 12 | 11 |
| June | 19 | 18 | 18 | 17 | 17 | 17 | 17 | 16 | 14 | 13 | 15 | 13 | 14 | 13 | 13 | 14 | 15 | 16 | 17 | 16 | 16 | 16 | 16 | 15 |
| July | 10 | 11 | 11 | 11 | 11 | 11 | 11 | 10 | 9 | 9 | 10 | 10 | 9 | 9 | 8 | 9 | 8 | 8 | 9 | 9 | 10 | 9 | 9 | 10 |
| August | 13 | 13 | 15 | 14 | 14 | 13 | 16 | 12 | 11 | 11 | 10 | 11 | 10 | 10 | 10 | 11 | 10 | 10 | 11 | 11 | 10 | 12 | 12 | 9 |
| September | 14 | 14 | 14 | 15 | 14 | 14 | 14 | 12 | 12 | 12 | 12 | 12 | 12 | 11 | 10 | 10 | 9 | 11 | 11 | 12 | 11 | 11 | 13 | 13 |
| October | 9 | 10 | 10 | 9 | 9 | 8 | 8 | 8 | 8 | 7 | 9 | 9 | 10 | 9 | 9 | 9 | 9 | 8 | 8 | 8 | 8 | 8 | 9 | 9 |
| November | 10 | 11 | 11 | 11 | 11 | 11 | 11 | 10 | 10 | 11 | 10 | 10 | 9 | 9 | 8 | 8 | 8 | 8 | 9 | 10 | 8 | 10 | 10 | 10 |
| December | 12 | 12 | 12 | 13 | 12 | 11 | 11 | 11 | 10 | 13 | 12 | 10 | 10 | 12 | 8 | 8 | 8 | 7 | 9 | 10 | 10 | 10 | 10 | 12 |
| Annual | 12 | 12 | 13 | 13 | 12 | 12 | 12 | 12 | 12 | 13 | 12 | 12 | 12 | 11 | 10 | 10 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 11 |

## APPENDIX IV.

KODAIKANAL mean hourly bright sunshine for the year 1916.

| Month. | Hours. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6-7 | 7-8 | 8-9 | 9-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 | 17-18 |
| January | 0·39 | 0·95 | 0·97 | 0·97 | 0·98 | 0·99 | 0·99 | 0·99 | 0·96 | 0·96 | 0·85 | 0·27 |
| February | ·50 | ·91 | ·93 | ·90 | ·89 | ·84 | ·79 | ·65 | ·61 | ·59 | ·51 | ·32 |
| March | ·24 | ·99 | ·93 | ·97 | ·97 | ·97 | ·91 | ·82 | ·75 | ·75 | 75 | ·37 |
| April | 1·00 | ·85 | ·92 | ·93 | ·92 | ·93 | ·93 | ·83 | ·63 | ·54 | ·39 | ·23 |
| May | 0·38 | ·70 | ·79 | ·87 | ·88 | ·84 | ·86 | ·79 | ·72 | ·64 | ·46 | ·18 |
| June | ·14 | ·36 | ·45 | ·44 | ·48 | 47 | ·38 | ·28 | ·16 | ·21 | ·15 | ·07 |
| July | ·24 | ·49 | ·70 | ·73 | ·72 | ·64 | ·54 | ·36 | ·23 | ·29 | 25 | ·13 |
| August | ·24 | ·52 | ·68 | ·68 | ·62 | ·54 | ·46 | ·37 | ·28 | ·27 | ·25 | ·10 |
| September | ·29 | ·55 | ·58 | ·59 | ·64 | ·58 | ·46 | ·27 | ·21 | ·20 | ·12 | ·07 |
| October | ·24 | ·55 | ·60 | ·51 | ·61 | ·50 | ·43 | ·45 | ·27 | ·21 | ·18 | ·02 |
| November | ·32 | ·65 | ·75 | ·76 | ·76 | ·72 | ·61 | ·49 | ·44 | ·40 | ·31 | ·09 |
| December | ·31 | ·72 | ·82 | ·82 | ·77 | ·77 | ·64 | ·62 | ·58 | ·51 | ·41 | ·14 |
| Mean | 0·37 | 0·71 | 0·79 | 0·80 | 0·80 | 0·75 | 0·69 | 0·59 | 0·50 | 0·48 | 0·39 | 0·17 |

## APPENDIX V.

NUMBER of days in each month on which the Nilgiris were visible in 1916.

| Month. | Very clear. | Visible. | Just visible. | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January | ... | 7 | 5 | 2 | 14 |
| February | ... | 1 | 1 | 1 | 3 |
| March | ... | 1 | ... | .. | 1 |
| April | ... | 1 | ... | ... | 1 |
| May | 1 | 1 | .. | ... | 2 |
| June | ... | 3 | ... | .. | 3 |
| July | 16 | 8 | ... | ... | 24 |
| August | 2 | 2 | 1 | 1 | 6 |
| September | 2 | 12 | 2 | ... | 16 |
| October | 3 | 12 | ... | ... | 15 |
| November | 1 | 9 | 4 | ... | 14 |
| December | ... | 9 | 4 | ... | 13 |
| Total | 25 | 66 | 17 | 4 | 112 |

# APPENDIX VI.

Madras Observatory—Abnormals from monthly means for the year 1916.

| Abnormals of | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure ... ... .. | + 0·024 | − 0·048 | − 0·015 | − 0·012 | − 0·004 | − 0·062 | − 0·014 | − 0·006 | − 0·086 | − 0·072 | − 0·045 | − 0·035 | − 0·028 |
| Temperature of air ... ... .. ... | + 0·5 | + 1·5 | + 0·3 | + 1·1 | + 0·8 | + 0·8 | − 0·9 | + 0·8 | + 1·5 | + 1·0 | + 1·3 | + 0·6 | + 0·8 |
| Do. of evaporation ... ... ... | Same as | + 1·3 | + 0·7 | + 1·2 | + 1·9 | + 0·1 | + 2·3 | + 1·8 | + 2·0 | + 1·7 | + 2·4 | + 0·2 | + 1·3 |
| Percentage of humidity ... ... ... .. | − 2 | + 1 | + 2 | + 1 | + 5 | − 1 | + 12 | + 3 | + 3 | + 4 | + 5 | − 1 | + 3 |
| Greatest solar heat in vacuo ... ... ... | + 10·1 | + 12·6 | + 13·2 | + 12·6 | + 6·9 | + 11·9 | + 3·5 | + 8·1 | + 13·9 | + 6·9 | + 6·7 | + 13·5 | + 10·0 |
| Maximum in shade ... ... ... ... .. | + 0·5 | + 1·7 | + 0·8 | + 1·2 | − 1·0 | + 1·5 | − 2·8 | + 0·4 | + 0·4 | Same as | − 0·4 | + 0·1 | + 0·3 |
| Minimum in shade ... ... ... .. ... | − 1·1 | + 1·1 | − 1·4 | + 0·9 | − 0·1 | + 0·2 | − 0·9 | + 0·6 | + 0·9 | + 1·1 | + 1·4 | − 0·1 | + 0·2 |
| Do. on grass ... ... ... .. ... | − 0·1 | + 2·6 | − 0·7 | + 1·8 | + 0·2 | + 1·2 | + 0·2 | + 1·6 | + 1·8 | + 2·3 | + 2·8 | + 0·7 | + 1·0 |
| Rainfall in inches ... ... ... ... ... | − 0·85 | − 0·28 | − 0·39 | − 0·60 | − 1·28 | + 1·30 | − 0·21 | − 2·36 | − 1·77 | + 4·30 | + 0·96 | − 1·37 | ... |
| Do. since January 1st ... ... ... ... | ... | − 1·13 | − 1·52 | − 2·12 | − 3·40 | − 2·10 | − 2·31 | − 4·67 | − 6·44 | − 2·14 | − 1·18 | − 2·55 | − 2·55 |
| General direction of wind ... ... ... ... | 1 point E | 3 points E. | 1 point E. | 1 point S. | 2 points E. | 1 point W. | 5 points S. | 1 point S. | 1 point W. | 10 points W. | 5 points E. | 1 point E. | 1 point S. |
| Daily velocity in miles ... ... ... ... | − 32 | − 2 | − 15 | − 9 | − 50 | − 21 | − 66 | − 27 | − 19 | Same as | − 26 | − 32 | − 25 |
| Percentage of cloudy sky ... ... .. ... | − 16 | − 9 | − 15 | − 6 | − 14 | + 3 | − 10 | − 6 | − 5 | − 1 | − 10 | − 11 | − 9 |
| Do. of bright sunshine ... ... ... | + 1·9 | + 0·1 | + 0·7 | + 1·9 | + 2·6 | − 9·0 | + 5·0 | − 0·3 | − 18·5 | − 8·5 | − 2·7 | + 1·5 | − 4·6 |

+ means above normal; — means below normal.

# APPENDIX VII.

ABSTRACT of the Mean Meteorological Condition of Madras in the year 1916 compared with the average of past years.

| Mean values of | 1916. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure ... ... ... ... ... | 29·836 | 0·028 below. | 29·864 |
| Temperature of air ... .. ... ... ... ... ... | 81·9 | 0·8 above. | 81·1 |
| Do. of evaporation ... ... ... ... ... | 75·8 | 1·3 ,, | 74·5 |
| Percentage of humidity .. .. . ... ... ... | 75 | 3 ,, | 72 |
| Greatest solar heat in vacuo ... ... ... ... ... | 149·7 | 10·0 ,, | 139·7 |
| Maximum in shade ... ... ... ... ... ... . | 91·1 | 0·3 ,, | 90·8 |
| Minimum in shade ... ... ... .. ... .. ... | 74·9 | 0·2 ,, | 74·7 |
| Do. on grass ... .. ... ... . ... .. | 72·9 | 1·0 ,, | 71·9 |
| Rainfall in inches since January 1st on 92 days .. ... | 46·47 | 2·55 below. | 49·02 |
| General direction of wind .. ... ... ... .. ... | S.E. by S. | 1 point S. | S.E. |
| Daily velocity in miles ... ... ... ... ... ... | 146 | 25 below | 171 |
| Percentage of cloudy sky ... ... ... ... ... ... | 40 | 9 ,, | 49 |
| Do. of bright sunshine ... ... ... ... ... | 53·8 | 4·6 ,, | 58·4 |

DURATION and Quantity of the Wind from different Points.

| From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 153 | 1,062 | East ... | 305 | 1,494 | South . | 187 | 1,112 | West ... | 300 | 2,380 |
| N. by E. | 163 | 928 | E. by S. | 366 | 1,800 | S. by W. | 210 | 1,293 | W. by N. | 133 | 1,051 |
| N. N. E. | 362 | 2,096 | E. S. E.... | 334 | 1,561 | S.S. W. ... | 242 | 1,381 | W. N. W. | 95 | 604 |
| N.E. by N. | 443 | 2,819 | S.E. by E. | 484 | 2,748 | S.W. by S. | 210 | 1,362 | N.W. by W. | 76 | 362 |
| N. E. | 213 | 1,518 | S. E. .. | 566 | 3,774 | S.W. ... | 191 | 1,180 | N. W. ... | 41 | 267 |
| N.E. by E. | 135 | 702 | S.E. by S. | 1,119 | 7,800 | S.W. by W. | 220 | 1,305 | N.W. by N. | 64 | 340 |
| E. N. E. | 228 | 1,054 | S. S. E. ... | 475 | 3,416 | W.S.W. ... | 250 | 1,737 | N.N.W. ... | 60 | 391 |
| E. by N | 258 | 1,044 | S. by E. | 280 | 1,683 | W. by S. | 393 | 2,907 | N. by W. | 55 | 368 |

There were 186 calm hours during the year. The resultant corresponding to the above numbers is represented by a S.E. wind, blowing with a uniform daily velocity of 20 miles.

# APPENDIX VIII.

Madras Observatory—Number of hours of wind from each point in the year 1916.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | .. | 9 | 88 | 94 | 86 | 51 | 103 | 78 | 60 | 64 | 57 | 37 | ... | ... | . | ... | ... | .. | . | ... | .. | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 17 |
| February | ... | ... | ... | ... | ... | 16 | 9 | 38 | 27 | 57 | 107 | 131 | 88 | 140 | 3 | 4 | 13 | 9 | 10 | 14 | 8 | 1 | ... | ... | ... | ... | ... | ... | ... | ... | .. | ... | 21 |
| March | ... | 2 | 14 | 1 | 1 | 1 | 16 | 43 | 68 | 63 | 50 | 90 | 45 | 193 | 89 | 14 | 7 | 14 | 11 | 9 | ... | ... | .. | ... | ... | ... | ... | .. | ... | .. | ... | ... | 13 |
| April | .. | ... | ... | .. | ... | | ... | ... | .. | . | ... | 20 | 119 | 363 | 105 | 21 | 12 | 17 | 17 | 20 | 6 | 1 | .. | 1 | 1 | ... | ... | ... | ... | ... | ... | ... | 17 |
| May | ... | .. | 1 | ... | 1 | 2 | 1 | 1 | 5 | 40 | 33 | 52 | 172 | 182 | 107 | 21 | 20 | 27 | 24 | 14 | 7 | 2 | 6 | ... | 3 | 2 | . | .. | 1 | 1 | 1 | ... | 18 |
| June | ... | 3 | 1 | ... | 1 | ... | 1 | 3 | .. | 2 | 13 | 4 | 4 | 33 | 28 | 53 | 34 | 9 | 14 | 39 | 44 | 57 | 77 | 150 | 91 | 28 | 15 | 7 | 4 | 1 | 10 | ... | 4 |
| July | 7 | 14 | . | ... | 1 | 5 | 2 | 5 | 19 | 33 | 29 | 28 | 59 | 78 | 50 | 40 | 28 | 45 | 52 | 31 | 15 | 42 | 42 | 33 | 20 | 13 | 8 | 13 | 4 | 8 | 1 | ... | 19 |
| August | 6 | 3 | 5 | 1 | 1 | .. | ... | 5 | 18 | 12 | 12 | 37 | 27 | 31 | 26 | 47 | 18 | 10 | 63 | 47 | 31 | 45 | 35 | 72 | 84 | 37 | 20 | 14 | 8 | 8 | 5 | 4 | 12 |
| September | ... | 1 | ... | 2 | 11 | 1 | 4 | 4 | 16 | 30 | 17 | 20 | 10 | 40 | 15 | 19 | 14 | 19 | 19 | 24 | 50 | 45 | 63 | 67 | 72 | 42 | 39 | 24 | 10 | 14 | 10 | 3 | 15 |
| October | 14 | 18 | 16 | 6 | 3 | 3 | 32 | 16 | 34 | 44 | 7 | 19 | 27 | 43 | 26 | 30 | 27 | 24 | 28 | 14 | 26 | 25 | 23 | 64 | 28 | 11 | 13 | 18 | 10 | 29 | 29 | 15 | 22 |
| November | 57 | 46 | 58 | 64 | 58 | 42 | 37 | 41 | 36 | 9 | 1 | 46 | 15 | 6 | 26 | 31 | 14 | 36 | 4 | 8 | 4 | 2 | 4 | 6 | 1 | . | .. | ... | 4 | 3 | 4 | 33 | 24 |
| December | 69 | 64 | 179 | 275 | 50 | 14 | 23 | 24 | 22 | 12 | 8 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4 |
| Annual total. | 153 | 160 | 362 | 443 | 213 | 135 | 228 | 253 | 305 | 366 | 334 | 484 | 566 | 1,119 | 475 | 280 | 187 | 210 | 242 | 210 | 191 | 220 | 250 | 393 | 300 | 133 | 95 | 76 | 41 | 64 | 60 | 55 | 186 |

# APPENDIX IX.

MADRAS OBSERVATORY—Number of miles of wind from each point in the year 1916.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | ... | 47 | 324 | 495 | 704 | 196 | 491 | 347 | 280 | 257 | 175 | 151 | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3,467 |
| February | ... | ... | ... | ... | ... | 60 | 71 | 178 | 154 | 306 | 513 | 630 | 541 | 595 | 25 | 29 | 83 | 60 | 68 | 99 | 57 | 6 | ... | ... | ... | ... | ... | | ... | ... | ... | ... | 3,475 |
| March | ... | 4 | 39 | 11 | 9 | 2 | 52 | 144 | 298 | 311 | 182 | 558 | 280 | 1,314 | 570 | 104 | 57 | 154 | 84 | 78 | ... | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | 4,251 |
| April | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 157 | 855 | 2,799 | 837 | 146 | 92 | 170 | 150 | 185 | 43 | 5 | ... | 6 | 4 | ... | ... | ... | ... | ... | ... | ... | 5,449 |
| May | ... | ... | 10 | ... | 9 | 25 | 11 | 9 | 48 | 227 | 290 | 418 | 1,259 | 1,561 | 715 | 181 | 132 | 160 | 183 | 104 | 35 | 11 | 43 | ... | 14 | 16 | ... | ... | 7 | 8 | 7 | ... | 5,483 |
| June | ... | 15 | 5 | ... | 6 | ... | 9 | 4 | ... | 16 | 45 | 37 | 40 | 303 | 253 | 371 | 226 | 63 | 82 | 213 | 331 | 402 | 666 | 1,399 | 991 | 292 | 108 | 17 | 35 | 3 | 37 | ... | 5,969 |
| July | 29 | 37 | ... | ... | 9 | 28 | 11 | 25 | 149 | 199 | 103 | 151 | 376 | 604 | 387 | 215 | 146 | 233 | 229 | 12[illegible] | 93 | 181 | 231 | 189 | 94 | 64 | 44 | 67 | 24 | 54 | 4 | ... | 4,104 |
| August | 29 | 15 | 7 | 5 | 3 | ... | ... | 31 | 58 | 76 | 76 | 224 | 148 | 148 | 170 | 184 | 121 | 55 | 303 | 331 | 236 | 284 | 270 | 463 | 697 | 274 | 147 | 74 | 55 | 46 | 24 | 16 | 4,570 |
| September | ... | 16 | ... | 10 | 75 | 3 | 45 | 23 | 82 | 123 | 65 | 137 | 65 | 236 | 112 | 101 | 77 | 95 | 110 | 115 | 243 | 266 | 375 | 461 | 440 | 321 | 227 | 78 | 66 | 58 | 51 | 22 | 4,098 |
| October | 68 | 124 | 83 | 75 | 19 | 25 | 134 | 70 | 171 | 165 | 55 | 110 | 143 | 166 | 126 | 148 | 91 | 128 | 145 | 71 | 123 | 142 | 127 | 350 | 145 | 83 | 78 | 126 | 60 | 162 | 209 | 92 | 3,814 |
| November | 434 | 276 | 422 | 500 | 297 | 271 | 130 | 119 | 181 | 47 | 9 | 175 | 67 | 74 | 221 | 204 | 87 | 175 | 27 | 37 | 19 | 8 | 25 | 39 | 3 | ... | ... | ... | 20 | 9 | 59 | 238 | 4,173 |
| December | 502 | 394 | 1,206 | 1,723 | 387 | 92 | 100 | 94 | 73 | 74 | 48 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4,693 |
| Annual. | 1,062 | 928 | 2,096 | 2,819 | 1,518 | 702 | 1,054 | 1,044 | 1,494 | 1,300 | 1,561 | 2,748 | 3,774 | 7,800 | 3,416 | 1,683 | 1,112 | 1,293 | 1,381 | 1,362 | 1,180 | 1,305 | 1,787 | 2,907 | 2,388 | 1,050 | 604 | 362 | 267 | 340 | 391 | 368 | 53,546 |

# APPENDIX X.

MADRAS OBSERVATORY—Number of inches of rain from each point in the year 1916.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | ... | ... | ... | ... | ... | ... | ... | ... | 0·04 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| February | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| March | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| April | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·02 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| May | ... | ... | ... | ... | ... | ... | ... | ... | 0·02 | ... | 0·01 | ... | ... | ... | ... | ... | 0·08 | 0·01 | ... | 0·71 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·01 |
| June | ... | ... | ... | ... | 0·47 | ... | ... | ... | ... | 0·02 | 0·17 | ... | 0·03 | | 0·08 | 0·05 | 0·02 | 0·14 | 0·50 | 0·03 | 0·06 | 0·05 | 0·31 | 0·69 | ... | 0·03 | 0·08 | ... | ... | ... | 0·68 | ... | ... |
| July | ... | ... | ... | ... | ... | 0·04 | 0·01 | ... | ... | 0·20 | ... | 0·24 | 0·04 | ... | 0·08 | ... | 0·76 | 0·24 | ... | ... | ... | 0·05 | ... | ... | ... | 0·81 | 0·06 | ... | 0·60 | 0·53 | ... | ... | ... |
| August | 0·03 | ... | ... | 0·08 | 0·02 | ... | ... | 0·13 | ... | ... | ... | 0·05 | 0·02 | 0·02 | ... | ... | ... | ... | 0·07 | ... | 0·02 | 0·09 | ... | 0·48 | ... | 0·72 | 0·24 | ... | 0·15 | 0·01 | ... | 0·05 | 0·02 |
| September | ... | 0·46 | ... | ... | ... | ... | ... | ... | ... | 0·14 | ... | 0·28 | ... | 0·02 | 0·06 | ... | 0·35 | 0·14 | 0·64 | 0·02 | 0·06 | 0·07 | 0·16 | ... | 0·23 | 0·02 | 0·03 | 0·18 | ... | 0·03 | 0·02 | 0·01 | ... |
| October | 3·74 | 1·27 | ... | 0·19 | 0·22 | 0·06 | 0·35 | ... | ... | 0·99 | 0·05 | 0·02 | 0·02 | ... | 0·03 | ... | 0·51 | 0·27 | 0·22 | 1·28 | 0·37 | 0·16 | 0·02 | 0·28 | 0·61 | 0·40 | 0·16 | 0·59 | 0·03 | 1·79 | 1·31 | 0·75 | 0·11 |
| November | 1·17 | 0·77 | 0·73 | 1·10 | 0·95 | 0·26 | 1·30 | 1·10 | 0·97 | 0·03 | ... | 0·34 | 0·23 | 0·22 | 0·51 | 1·78 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·21 | 0·10 | 0·55 | 1·82 | 0·03 |
| December | 0·70 | 0·07 | 0·63 | 0·30 | 0·01 | 0·38 | 0·03 | 1·64 | 0·01 | 0·14 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | ... |
| Annua | 5·64 | 2·57 | 1·36 | 1·67 | 1·67 | 0·74 | 1·69 | 2·87 | 1·04 | 1·52 | 0·23 | 0·93 | 0·34 | 0·28 | 0·76 | 1·83 | 1·22 | 0·80 | 1·43 | 2·04 | 0·51 | 0·42 | 0·49 | 1·45 | 0·84 | 1·98 | 0·57 | 0·77 | 0·99 | 2·46 | 2·56 | 2·63 | 0·17 |

# APPENDIX XI.

MADRAS OBSERVATORY—Wind, cloud and bright sunshine, 1916.

| Month. | Wind resultant. | | Cloud (0—10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H. | 16 H. | 20 H. | Mean. | Average per day. | Greatest number of hours in a day. |
| | MILES. | POINTS. | | | | | | HOURS. | HOURS. |
| January | 97 | E.N.E. | 2·3 | 2·7 | 2·1 | 1·2 | 2·1 | 8·0 | 9·2 |
| February | 101 | S.E. by E. | 1·1 | 2·0 | 1·7 | 1·2 | 1·5 | 9·0 | 10·3 |
| March | 117 | S.E. | 0·9 | 1·5 | 0·8 | 0·5 | 0·9 | 8·9 | 10·7 |
| April | 171 | S.S.E. | 2·5 | 2·3 | 2·3 | 1·4 | 2·2 | 8·8 | 10·7 |
| May | 155 | S.E. by S. | 3·1 | 2·5 | 1·7 | 2·1 | 2·4 | 8·0 | 10·5 |
| June | 111 | S.W. by W. | 5·8 | 5·3 | 8·2 | 7·5 | 6·7 | 3·9 | 7·4 |
| July | 69 | S. by E. | 6·7 | 6·2 | 5·7 | 5·6 | 6·1 | 4·6 | 9·0 |
| August | 97 | S.W. | 5·4 | 6·0 | 7·2 | 5·6 | 6·1 | 4·9 | 10·8 |
| September | 70 | S.W. by W. | 5·8 | 5·6 | 6·1 | 5·1 | 5·7 | 5·3 | 11·5 |
| October | 115 | S.W. | 5·7 | 5·9 | 6·5 | 4·9 | 5·8 | 4·9 | 10·3 |
| November | 66 | N.E. | 4·6 | 5·7 | 5·8 | 3·5 | 4·9 | 5·2 | 9·7 |
| December | 128 | N.E. by N. | 4·0 | 4·8 | 3·9 | 3·6 | 4·1 | 6·2 | 8·6 |
| Annual | 20 | S.E. | 4·0 | 4·2 | 4·3 | 3·5 | 4·0 | 6·5 | ... |

# APPENDIX XII.

## Mean Monthly and Annual Meteorological Results at the Madras Observatory in 1916.

| Month. | Barometer. | | Dry Bulb Thermometer. | | | | Wet Bulb. | | Tension of Vapour. | Relative Humidity. | Sun Max in Vac. | Min. on Grass. | Wind. | | | Rain. | | Cloudy Sky. | Bright Sun-shine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reduced to 32°. | Daily Range | Mean. | Max. | Min. | Range. | Mean. | Min. | By Blanford's Tables. | | | | Daily Velocity. | Mean Direction. | | Amount. | Days. | | |
| | Inches. | Inches | ° | ° | ° | ° | ° | ° | Inches. | Cents. | ° | ° | Miles | Points. | | Inches. | No. | Cents. | Hours. |
| January | 30·021 | 0·116 | 75·6 | 85·1 | 66·4 | 18·7 | 69·2 | 64·9 | 0·626 | 71 | 148·5 | 63·0 | 112 | 6 | E.N.E | 0·04 | **1** | 21 | 247·1 |
| February | 29·917 | ·129 | 78·2 | 88·3 | 69·1 | 19·2 | 72·1 | 68·2 | ·707 | 74 | 152·3 | 63·4 | 120 | 11 | S.E. by E | ... | ... | 15 | 261·5 |
| March | ·890 | ·132 | 80·3 | 90·0 | 70·7 | 19·3 | 74·6 | 70·3 | ·782 | 76 | 153·7 | 67·9 | 137 | 11 | S.E. by E. | ... | ... | 9 | 277·3 |
| April | ·814 | ·133 | 85·1 | 94·1 | 78·1 | 16·0 | 78·8 | 76·3 | ·898 | 75 | 154·3 | 76·5 | 182 | 14 | S.S.E. | 0·02 | 1 | 22 | 265·6 |
| May | ·731 | ·120 | 87·5 | 96·8 | 80·7 | 16·1 | 80·2 | 77·5 | ·932 | 72 | 149·9 | 79·1 | 177 | 13 | S.E. by S. | 0·84 | 3 | 24 | 247·9 |
| June | ·642 | ·134 | 87·2 | 99·8 | 80·5 | 19·3 | 76·7 | 73·7 | ·777 | 61 | 152·4 | 79·8 | 199 | 20 | S.W. | 3·41 | 11 | 67 | 118·1 |
| July | ·706 | ·109 | 83·6 | 92·8 | 77·6 | 15·2 | 78·2 | 75·2 | ·890 | 77 | 142·2 | 76·8 | 132 | 15 | S. by E. | 3·66 | 11 | 61 | 143·6 |
| August | ·743 | ·129 | 84·4 | 94·1 | 77·9 | 16·2 | 77·8 | 74·9 | ·861 | 73 | 148·1 | 77·0 | 147 | 18 | S.S W. | 2·20 | 10 | 61 | 153·0 |
| September | ·712 | 125 | 84·5 | 93·6 | 78·0 | 15·6 | 78·3 | 74·9 | ·881 | 75 | 155·2 | 76·8 | 137 | 19 | S.W. by S. | 2·92 | 14 | 57 | 160·2 |
| October | ·778 | ·121 | 81·6 | 89·0 | 76·3 | 12·7 | 77·3 | 74·8 | ·876 | 82 | 146·0 | 75·1 | 123 | 17 | S. by W. | 15·30 | **15** | 58 | 151·9 |
| November | ·879 | ·110 | 78·8 | 85·5 | 73·7 | 11·8 | 75·3 | 72·5 | ·831 | 84 | 144·1 | 72·3 | 139 | 7 | E. by N. | **14·17** | **18** | 49 | 155·0 |
| December | 944 | ·108 | 76·1 | 83·7 | 69·7 | 14·0 | 70·3 | 68·0 | ·683 | 76 | 149·3 | 67·1 | 151 | 3 | N.E. by N. | 3·91 | 8 | 41 | 190·9 |
| Annual ... | 29·815 | 0·122 | 81·9 | 91·1 | 74·9 | 16·2 | 75·8 | 72·6 | 0·812 | 75 | 149·7 | 72·9 | 146 | 13 | S.E. by S. | 46·47 | 92 | 40 | 2,372·1 |

## Extreme Monthly Meteorological Records at the Madras Observatory in 1916.

| Month. | Barometer. | | | | | Dry Bulb Thermometer. | | | | Wet Bulb. | | Humidity. | | Sun Th. in Vacuo. | | Grass Therm. | | Wind. | | | | Rain. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | | Lowest. | | Range | Highest. | | Lowest. | | Lowest. | | Lowest. | | Highest. | | Lowest. | | Highest. | | Lowest. | | Greatest Fall. | |
| | Inches. | Day. | Inches. | Day. | Inches | ° | Day. | ° | Day. | ° | Day. | Cents. | Day. | ° | Day. | ° | Day. | Miles. | Day. | Miles. | Day. | Inches. | Day. |
| January | **30·149** | **11** | 29·887 | 31 | 0·262 | 86·5 | 30 | **62·6** | **19** | **60·9** | **19** | 47 | 12 | 152·3 | 29 | **58·4** | **19** | 257 | 12 | 65 | 26 | 0·04 | 9 |
| February | ·064 | 12 | ·791 | 22 | 273 | 97·3 | 29 | 62·7 | 5 | 61·9 | 5 | 31 | 3 | 160·2 | 29 | 58·7 | 5 | 154 | 22 | 70 | 2 | ... | ... |
| March | ·009 | 27 | ·690 | 30 | 319 | 96·1 | 30 | 65·9 | 8, 9, 10 | 65·5 | 10 | 40 | 30 | 159·6 | 13 | 62·4 | 8 | 201 | 30 | 84 | 11 | ... | ... |
| April | 29·963 | 5 | ·636 | 21 | ·327 | 101·2 | 24 | 74·7 | 3 | 74·2 | 28 | 44 | 24 | 161·6 | 6 | 72·0 | 3 | 220 | 26, 19 | 140 | 22 | 0·02 | 1 |
| May | ·888 | 10 | ·585 | 15 | ·303 | 103·4 | 4 | 74·7 | 31 | 71·9 | 31 | 34 | 29 | 155·6 | 9 | 74·7 | 31 | 249 | 26 | 125 | 21 | 0·81 | 31 |
| June | ·838 | 30 | **·436** | **13** | **·402** | **104·5** | **7** | 74·6 | 1 | 71·7 | 1 | **29** | **13** | 165·9 | 16 | 74·5 | 29 | 259 | 21 | 130 | 30 | 0·96 | 18 |
| July | ·868 | 14 | ·581 | 25 | ·287 | 99·4 | 1 | 73·1 | 4, 5 | 71·8 | 11 | 47 | 2 | 157·0 | 19 | 73·2 | 27 | 274 | 18 | 63 | 23 | 1·53 | 4 |
| August | ·902 | 10 | ·567 | 1 | ·335 | 100·2 | 14 | 75·6 | 25 | 72·7 | 13, 14 | 38 | 14 | 161·3 | 24 | 74·3 | 16 | 217 | 13 | 99 | 29 | 0·63 | 23 |
| September | ·845 | 2 | ·571 | 10 | ·274 | 99·4 | 4 | 74·5 | 6 | 72·9 | 26 | 42 | 24 | 167·9 | 23 | 73·7 | 24 | 192 | 23 | 181 | 7 | 0·98 | 11 |
| October | ·909 | 10 | ·628 | 1 | ·281 | 98·4 | 3 | 72·5 | 21 | 71·3 | 23 | 53 | 1 | **169·4** | **3** | 70·2 | 21 | 217 | 22 | 66 | 18 | **5·09** | **15** |
| November | 30·040 | 19 | ·679 | 22 | ·361 | 92·8 | 3 | 68·8 | 22 | 68·1 | 23 | 45 | 2 | 164·3 | 8 | 68·3 | 26 | **369** | **22** | **33** | **7** | 2·95 | 22 |
| December | ·036 | 15 | ·837 | 27 | ·199 | 85·8 | 2 | 64·1 | 25 | 63·5 | 25 | 49 | 24 | 155·5 | 26 | 60·3 | 25 | 247 | 8 | 95 | 19, 30 | 1·37 | 3 |

# ANNUAL REPORT

OF THE

# DIRECTOR

# KODAIKANAL AND MADRAS OBSERVATORIES

# FOR 1917

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# KODAIKANAL AND MADRAS OBSERVATORIES.

## REPORT FOR THE YEAR 1917.

### CONTENTS.

#### I.—Kodaikanal Observatory.



#### II.—Madras Observatory.

# KODAIKANAL AND MADRAS OBSERVATORIES.

## I.—REPORT OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1917.

*Staff.*—The staff of the Observatory on December 31, 1917, was as follows :—

| | |
|---|---|
| Director ... ... ... ... | J. Evershed, F.R.S. (on privilege leave). |
| Assistant Director ... ... ... | T. Royds, D.Sc. (on deputation).<br>S. Sitarama Ayyar, acting sub. *pro tem.* |
| First Assistant ... ... ... | S. Sitarama Ayyar, B.A.<br>G. Nagaraja Ayyar, acting sub. *pro tem.* |
| Second Assistant ... ... ... | G. Nagaraja Ayyar.<br>A. A. Narayana Ayyar, acting sub. *pro tem.* |
| Third Assistant ... ... ... | A. A. Narayana Ayyar, B.A.<br>S. Balasundaram Ayyar, acting sub. *pro tem.* |
| Fourth Assistant ... ... ... | S. Balasundaram Ayyar. |
| Writer ... ... ... ... ... | L. N. Krishnaswami Ayyar. |
| Photographic Assistant ... ... | R. Krishna Ayyar. |

MAGNETIC SECTION.

| | |
|---|---|
| Magnetic Observer ... ... ... | S. S. Ramaswami Ayyangar, B.A. |
| Magnetic Recorder ... ... ... | S. S. Ranga Acharya. |

The Observatory has temporarily lost the services of Dr. Royds who volunteered for military service in November 1916 but continued his work as Assistant Director until October 1917 when he was appointed Assistant to the Director of Ordnance Factories. He left Kodaikanal on October 23 to take up this appointment at Calcutta. First Assistant S. Sitarama Ayyar has been appointed Assistant Director substantive *pro tempore* from October 24.

The subordinate staff consists of a book-binder, an assistant book-binder, a mechanic, six peons (including the peon of the Magnetic Observatory), a boy peon for the dark room and two lascars.

2. *Instruments.*—The instrumental equipment of the Observatory was the same as in the last report with the exception of some additions and reconstructions mentioned in paragraphs 16 to 19. The Kullberg sidereal chronometer has been lent to the Nizamiah Observatory, Hyderabad.

3. *Weather conditions.*—The weather during the year has been generally unfavourable for all classes of work owing to diffusive skies and bad definition during the dry season, and heavy monsoon conditions from May to October and in November.

*Photographic and visual observations.*

4. *Photoheliograph.*—Work with this instrument was resumed from February 11 and photographs on a scale of 8 inches to the sun's diameter were obtained on 294 days.

5. *Spectroheliographs.*—Notwithstanding the poor weather conditions there was very little reduction in the number of plates obtained, although the quality of these has suffered.

Monochromatic images of the disc in K light were obtained on 328 days, prominence plates on 262 days, and H$\alpha$ disc plates on 255 days.

6. *Six-inch Cooke equatorial and spectroscope.*—Work with this instrument has been continued on the same lines as formerly for visual observations of solar phenomena which cannot be readily photographed.

7. *Grating spectrograph.*—This instrument has been greatly improved for work requiring long exposures by surrounding and covering the grating chamber with closely packed sand bags, and by erecting a screen outside the west wall of the building as a protection from heating by the afternoon sun. A telescope with collimating lens has also been added for reading a sensitive thermometer, the bulb of which is inserted in the grating chamber. The diurnal range of temperature now seldom reaches 0°·5 Fahrenheit and a change exceeding 0°·01 Fahrenheit rarely occurs in a two hours exposure. The instrument has been used for researches connected with the general displacement of the lines of the solar spectrum with reference to the arc lines. Two series of photographs have been obtained of the spectrum of Venus with Fe arc comparison lines, and of control plates of sky light and Fe arc. During the monsoon months a large number of plates were obtained of the iron arc spectrum in order to test the stability of the Fe lines under various conditions, and for investigating the "pole effect" in different regions of the arc. The sensitiveness to pole effect has also been determined for all the lines used in the Venus plates.

The Venus spectra are for discovering whether the general shift towards red of the lines at all points on the visible disc of the sun affects also a hemisphere of the sun turned 90° or more from the earth. If there is no difference of wave-length in the light reflected by Venus and ordinary sunlight then the displacements observed cannot be interpreted by motion of the solar gases, whilst if the Venus spectra show a smaller wave-length an earth effect is involved. If the hidden hemisphere of the sun should yield normal wave-lengths then it would follow that the sun's gravitational field is not concerned in the line shifts.

### *General results of the spectrographic work.*

8. *The Venus spectra.*—Measures of the first series of Venus and sky spectra photographed when the planet was a morning star indicate distinctly smaller wave-lengths of the Fe lines in the integrated solar spectra reflected by Venus compared with sky light, when the angle Venus-Sun-Earth was about 140°. The difference of wave-length Sun − Venus for the mean of 12 lines is + 0·007A. This result is possibly vitiated by imperfect control of the pole effect, the arc used had nickel for positive pole and iron for negative, and the integrated light from the entire arc formed the spectrum. It has since been found that under these conditions the Fe lines are slightly unstable in wave-length, and even those which are apparently unaffected at the negative pole are liable to be displaced.

The second series of spectra with the planet an evening star was secured with the iron arc under more carefully controlled conditions and without nickel. Unfortunately during the most favourable presentation of the planet in July, August and September, the evening sky was continuously overcast, and not a single exposure could be obtained until October, when the angle Venus-Sun-Earth had become reduced to about 62°. Five spectra were obtained during October under more or less cloudy conditions, and the measures of these, and of the similar sky spectra, show a small but apparently trustworthy difference, the mean wave-length of 18 Fe lines in Venus being 0·0034A smaller than in the sky spectra. The evidence so far obtained may therefore be said to favour the motion interpretation of the solar displacements involving an Earth effect.

A third series of photographs will be attempted after April 1918 with the planet again a morning star and coming into favourable positions in June and July.

The Venus plates have also been used to determine the relative velocity of Venus and the Earth in the line of sight. With the planet near elongation and a dispersion of 1 mm = 1·4A the linear displacement is about 0·14 mm, and the dispersion could probably be doubled if an

uninterrupted exposure of two hours' duration could be given. It is hoped that in the clearer morning skies this may be possible. It has been found from the October plates that the probable error of a displacement determination averages 1 part in 400 for each plate, measuring 40 lines by the positive on negative method. By combining the results from both east and west elongations the uncertainty due to a possible difference of wave-length in the reflected and direct light is eliminated, and the measures can be used to find a correction to the adopted solar parallax. A preliminary result derived from the first and second series of plates indicates an extremely small correction, but since the quantity measured is several times smaller than the parallax displacement in astrographic plates of Eros this result can only be considered as a guarantee of the reliability of the plates.

9. *Pole effect.*—The investigations relating to pole effect have shown that all the Fe lines suitable for measurement between 4337 and 4494 are subject to slight displacements towards red near the negative pole, even those classified *a*3, *b*1 and *b*3 which are supposed to be symmetrical lines. The positive on negative method has been found to be extremely useful in detecting small displacements of 0·002A or over, without the labour of measurement, and with spectra representing longitudinal sections of the arc from pole to pole this method at once detects and locates the position in the arc of any displacements. In this way it has been discovered that when iron forms the negative pole and nickel or some other metals the positive there is a tendency for the displacement at the negative pole to extend across the arc to the central region. Also it is found that in the central region of a 6-ampere arc of 6 to 8 mm. length most of the lines in the region studied show a tendency to shift towards red with increasing exposure time, showing that under ordinary arc conditions they are unsymmetrically widened towards red to a very slight degree. In lines which easily reverse, such as 4383 and 4404, the reversal is found to have the minimum wave-length, and agrees in position with the emission line when the density of the bright line image is small. This dependence of wave-length on exposure time accounts for many inconsistencies in determinations of Sun – arc displacements.

10. *Sun and arc comparison spectra.*—A considerable number of sun and arc plates have been obtained and measured during the year: these include 2nd, 3rd and 4th order spectra of the region photographed in Venus. These plates show the influence of density of the arc images on the measured shifts of the solar lines, and the effect of using nickel as positive pole, thus confirming the results already described. In addition a series of high dispersion spectra of Fe arc and general sunlight were obtained which appear to give sun – arc shifts practically the same as when the centre of the sun's disc is used, but further measures are needed to settle this point.

Some plates obtained by Dr. Royds of the centre of the disc and Fe arc in the region including the telluric oxygen lines of the *a* group have been measured in order to test the observation reported by Perot that the telluric oxygen lines of the group B indicate a motion shift amounting to 3 km/sec in a vertical direction. The result of measures of plates taken with high and low sun gives an entirely negative result: the lines of the *a* group show no measurable shift depending on altitude.

11. *Spectrographic determination of the solar rotation.*—A new scheme of work was developed in the favourable atmospheric conditions in Kashmir in 1916, but owing to persistent diffusive and cloudy skies throughout the past year at Kodaikānal no progress was possible. The method is to photograph the east and west limb spectra in the red region near to and including the H$\alpha$ line, and to measure these by the positive on negative method, confining attention to the strongest Fe and Ca lines and the hydrogen line. These lines can be measured in this way with far greater accuracy and greater freedom from systematic errors than

by the usual method, and the lines chosen are less affected by atmospheric diffusion than weaker lines or lines in the more refrangible regions. Variations in the solar rotation of 1 per cent could, it is believed, be detected with certainty by this method, and with a minimum of labour in measurement.

*Work with the 8-inch horizontal telescope.*

12. *Star photography in daylight.*—At the request of Mr. Lindemann an effort was made to observe the conjunction of Regulus and the Sun on August 22 by the photographic method initiated by him. Light from the siderostat was passed through two large prisms each of 6 inch aperture and 45° angle but placed 35 feet apart and in reversed positions, the second prism taking up and recombining only the red and infra red rays which then enter the 8-inch telescope. The more refrangible red rays were cut out by an absorbing screen of cobalt glass placed near the focus. As the sun would be in the field of the telescope together with the star an arrangement was constructed whereby the sun's image could be reflected out of the tube during the exposure on the star but yet admitting of an instantaneous exposure, so that a record might be obtained of both sun and star on the same plate. Measures of the distance of the star from the sun's limb would then be used to discover whether there was any displacement of the star due to the gravitational field of the sun.

The day of conjunction was not clear enough to test the method satisfactorily, and no star image appeared on the plates obtained, nor could the star be seen visually during fairly clear intervals. The definition of the sun appeared very good and the spots seemed darker than with ordinary light.

*Summary of sunspot and prominence observations.*

13. *Sunspots.*—The following table shows the monthly numbers of new groups observed at Kodaikānal and their distribution between the northern and southern hemispheres. The mean daily numbers of spots visible are also given :—

| — | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups .. .. | 32 | 28 | 24 | 26 | 30 | 21 | 31 | 45 | 37 | 28 | 24 | 39 | 365 |
| North ... ... | 17 | 13 | 16 | 12 | 17 | 12 | 23 | 20 | 19 | 13 | 13 | 18 | 193 |
| South ... . | 15 | 15 | 8 | 14 | 13 | 9 | 8 | 25 | 18 | 15 | 11 | 21 | 172 |
| Daily numbers ... | 6·0 | 5·0 | 5·6 | 5·1 | 6·7 | 6·9 | 6·7 | 8·8 | 7·6 | 4·9 | 5·4 | 9·3 | 6·5 |

There is an increase in the number of new groups recorded of 31 per cent and of mean daily numbers visible of 67 per cent compared with the previous year. There was no day in 1917 on which no spots were recorded.

The preponderance of activity in the northern hemisphere is somewhat less marked than in 1916. The approximate mean latitude was 14°·1 in the northern and 17°·1 in the southern hemisphere, a decrease of 1°·9 and 1°·3 respectively compared wth the previous year. Judging by the mean latitudes it would appear that the maximum of the sunspot cycle had not yet been reached, although the northern hemisphere alone may possibly have attained its greatest activity. There were 483 reversals of the hydrogen lines, 40 darkenings of $D_3$, and 133 displacements of H$\alpha$ recorded during the year.

The largest spots observed during the present cycle crossed the sun's disc in February and in August.

14. *Prominences.*—The mean daily areas of prominences in square minutes of arc derived from the Kodaikānal photographic records are as follows :—

| — | North. | South. | Total. |
|---|---|---|---|
| 1917—January to June ... ... | 2·94 | 2·42 | 5·36 |
| July to December . ... | 2·83 | 2.12 | 4·95 |

These figures indicate a considerable increase of activity compared with the previous year and show that the reduction in 1916 was of a temporary character. The mean daily number of prominences recorded during the year was 19·8.

The distribution in latitude indicates a close approach to the climax in prominence development when the high latitude zones of activity reach the polar regions. The northern zone is shown to have a maximum between 75° and 80° and the southern between 70° and 75° : the north is thus slightly ahead of the south in its approach towards the pole, and a complete disappearance of these northern prominences may be anticipated during 1918, whilst the southern zone may be expected to continue active some time longer. The northern hemisphere has continued more active than the south and this applies also to prominences projected on the disc as absorption markings, to metallic prominences, and to displacements of the hydrogen lines indicating violent motion.

The prominence areas east and west of the sun's axis show a slight western excess, the proportion on the east side being 49·6 per cent of the whole. The denser prominences showing as absorption markings on the disc indicate on the other hand the usual eastern excess, the areas east of the meridian being 52·8 per cent of the whole, derived from 4725 markings. $D_3$ darkenings and bright reversals of hydrogen lines on the disc were also slightly more frequent east of the meridian ; but of 51 metallic prominences observed at the limb only 19 were east. Three hundred and seventy-five displacements of H*α* were recorded in the chromosphere and prominences, and of these 52·5 per cent were on the east limb.

The usual preponderance of displacements of the hydrogen lines towards red is shown both in prominences at the limb and near spots on the disc.

*Solar radiation.*

15. *Pyrheliometer.*—Very few days in 1917 were clear enough for solar radiation measures, but a series of observations was secured by Dr. Royds early in the year with the Angstrom pyrheliometer No. 73, and the results are given in the following table. In this E is the solar constant or the amount of heat which would be received outside the earth's atmosphere, in calories per square centimetre per minute, and $a$ is the transmissive power of the earth's atmosphere.

| Date. | | E | $a$ | Remarks. |
|---|---|---|---|---|
| February ... | 16 | 1·813 | 0·903 | |
| ,, | 19 | 1·731 | 0·856 | |
| ,, ... | 22 | 1·730 | 0·879 | |
| ,, | 23 | 1·781 | 0·881 | |
| ,, ... | 25 | 1·848? | 0·841? | |
| ,, ... | 27 | 1·769 | 0·875 | |
| ,, ... | 28 | 1·711 | 0·860 | |
| March ... | 1 | 1·534? | 0·938? | |
| ,, ... | 2 | 1·702 | 0·888 | |
| ,, ... | 8 | 1·687 | 0·877 | |
| ,, ... | 9 | 1·687 | 0·879 | |
| ,, ... | 10 | 1·689? | 0·873? | Incomplete. |
| ,, ... | 11 | 1·731 | 0·855 | |
| ,, ... | 12 | 1·672 | 0·873 | |
| ,, ... | 13 | 1·671 | 0·876 | Forenoon observations |
| March ... | 13 | 1·709 | 0·836 | Afternoon observations. |
| ,, .. | 14 | 1·728 | 0·858 | |
| ,, .. | 15 | 1·672 | 0·874 | |
| ,, .. | 16 | 1·723 | 0·890 | |
| ,, ... | 17 | 1·701 | 0·890 | |
| ,, ... | 18 | 1·662 | 0·896 | |
| ,, ... | 23 | 1·655 | 0·886 | |
| ,, ... | 29 | 1·680 | 0·897 | |
| April ... | 4 | 1·681 | 0·901 | |
| ,, ... | 14 | 1·602 | 0·894 | |
| May ... | 4 | 1·665 | 0·892 | |
| ,, ... | 12 | 1·598 | 0·885 | |
| ,, ... | 14 | 1·635 | 0·887 | |

Dr. Royds adds the following remarks :—

"The instrumental constant supplied by the makers has been used, although the absorptive power is at any rate much lower than its assumed value. The values of the solar constant therefore require to be multiplied by an undetermined factor before comparing with observations at other stations.

"Whilst the variations from day to day may not be real it would seem from the observations that the value of the solar constant was falling from February to May."

*Workshop construction.*

16. Dr. Royds has constructed and made experiments with interference standards of the pattern of Fabry and Perot with a view to their use in determining solar displacements with great accuracy. His apparatus is ready for mounting in front of the spectrograph when observing conditions are favourable.

17. A new prism spectrograph for use with the 15-inch Hyderabad lens, or the 20-inch mirror from Poona, was constructed during the year. The prism box is large in order to accommodate any prism train. Two 45° prisms of 6-inch aperture are at present used with collimator of 3-foot and camera 5-foot focal lengths. The spaces surrounding the prisms are filled with small closely packed sand bags. The prism box is mounted on a carriage having 3 flanged wheels running on iron rails in order that the instrument may be run into position in the beam of light from the siderostat which also feeds the spectroheliograph. The immediate purpose of this spectrograph was to obtain Venus and Fe arc spectra when the planet was too near superior conjunction for long exposures with the grating spectrograph, but atmospheric conditions were unfavourable throughout the period when it would have been of use.

18. A new microscope specially adapted for positive on negative measures was fitted to the usual form of Hilger micrometer. This instrument has been fitted with a new high quality screw and can be used for positive on negative or ordinary filar measures. The eye piece carrying a single thread has also been reconstructed and a screw arrangement provided for rotating the thread through a small angle ; this is an almost indispensable aid in spectrum measures but one which appears never to be provided by instrument makers.

19. The 8-inch telescope from Poona was erected horizontally and fitted with a special form of camera intended for photographing Regulus in red light when near the sun.

*Time, meteorology, etc.*

20. *Time.*—The error of the standard clock is usually determined by reference to the 16-hour signal from the Madras Observatory. This is rendered possible by the courtesy of the Telegraph Department which permits the Madras wire to be joined through to this observatory. The signal is received with accuracy on most days and all failures are at once reported to the Postmaster-General, Madras.

21. *Meteorology.*—Eye observations are made at $8^h$, $10^h$ and $16^h$ local mean time as in former years. The Richard thermograph (wet and dry bulb) and barograph, the Beckley anemograph, and the sunshine recorder also continue in use. Cloud observations with the nephoscope are made three times daily.

*Pressure.*—The mean pressure was below normal in every month of the year, the defect ranging from 0·003 inch in May, to 0·046 inch in October. The mean for the year was 0·023 inch below normal.

*Temperature.*—The annual mean temperature was 1° above normal, the mean maximum almost normal and the mean minimum 1° below normal.

*Humidity.*—The annual mean humidity was slightly above normal.

*Rainfall.*—There was an excess of rain in February, May, June, August, September and November, the total fall for the year exceeding the average by 7·9 inches. The greatest monthly excess and also the

heaviest fall for a day, occurred in February, usually the driest montl of the year.

*Wind.*—The mean wind velocity was in excess of normal i January but in defect in every other month, especially in July, Augus and September.

*Cloud and sunshine.*—The mean cloudiness was greater than norma but the number of hours of bright sunshine actually exceeded th average by 8 per cent.

22. *Seismology.*—Seventy-two earthquakes were recorded on the Miln horizontal pendulum. Details of the records are given in Appendix I.

23. *Library.*—One hundred and two volumes were bound during th year.

24. *Publications.*—Volume I, part 2 of the Observatory Memoirs anc five bulletins were published during the year, but under instructions from Government only a few copies were distributed privately outsid India. The titles are—

Memoirs, Volume I, part 2.—Results of Prominence Observations, by J. Evershed, F.R.S. and M. A. Evershed.

Bulletin No. LIII.—The displacement of nickel and titanium lines in the sun and arc by T. Royds, D.Sc.

„ No. LIV.—The cause of the so-called pole effect in the electric arc, by T Royds, D.Sc.

„ No. LV.—The solar prominence of 1916, May 26, by J. Evershed, F.R.S.

„ No. LVI.—Summary of prominence observations for the second-half of th year 1916, by T. Royds, D.Sc.

„ No. LVII.—Summary of prominence observations for the first-half of th year 1917, by T. Royds, D.Sc.

In addition the following contributions to "The Observatory" were made by the Director :—

The Einstein Effect and the Eclipse of 1919, May 29, XL, 269.
Day and night "seeing" ... ... ... ... XL, 400.

J. EVERSHED,
*Director, Kodaikanal and Madras Observatories.*

KODAIKANAL,
*7th February* 1918.

## II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1917.

*Staff.*—The staff at the Observatory during the year 1917 was as follows :—

| | |
|---|---|
| Deputy Director ... ... ... ... | R. Ll. Jones. |
| Computer ... ... ... ... ... | S. Solomon Pillai. |
| First Assistant ... ... ... ... | C. Chengalvaraya Mudaliyar. |
| Second Assistant ... ... ... ... | E. Ramanujam Pillai. |

2. *Time service.*—The time gun at Fort St. George failed on 20 occasions out of 730, giving a percentage of success of 97. The semaphore failed both at 1 and 2 p.m. on two occasions, failed at 1 but dropped at 2 p.m. on eleven occasions and dropped correctly at 1 p.m. on all other occasions. The 4 p.m. roll of signals was sent and received at the Central Telegraph Office, for distribution over India, correctly on every day except one. On this occasion—22nd November—the signals were not received at the Central Telegraph Office owing to a fault in the circuit at the Observatory. The circuit arrangements here have since been changed so as to permit easier inspection and detection of such faults in future.

3. *Meteorological observations.*—Eye observations were made at $8^h$, $10^h$, $16^h$, and $20^h$, local mean time as in former years. The Richard thermograph and barograph, the Beckley anemograph, the sunshine recorder and self-registering rain-gauge also continue in use. Extra observations were taken for storm warning purposes and telegrams sent to Calcutta on 69 occasions.

4. *Buildings, etc.*—The usual annual repairs to the office and quarters were carried out during the year. The subsoil drain constructed round the observatory was in part effective in stopping the variations in level of the transit instrument and the changes have been smaller during the past year.

5. *Instruments.*—The following is a list of the instruments at the Observatory on 31st December 1917 :—

*Astronomical.*

Eight-inch Equatorial Telescope—Troughton and Simms.
Sidereal clock—Haswall.
Do. Dent, No. 1408.
Do. S. Riefler, No. 61.
Mean Time clock—J. H. Agar Baugh, No. 105.
Do. with galvanometer—Shepherd and Sons.
Meridian circle—Troughton and Simms.
Portable transit instrument—Dolland.
Portable telescope with stand.
Tape chronograph—R. Fuess.
Relay for use with the chronograph—Siemens.

*Meteorological.*

Richard's barograph—No. 10, L. Casella.
Do. thermograph—No. 29637, L. Casella.
Peander's self-recording rain-gauge—No. 116, Lawrence and Mayo.
Beckley's anemograph—Adie.
Sunshine recorder—No. 149, L. Casella.
Nephoscope—Mons. Jules Daboseq Ph. and Pellin.
Barometer, Fortins—No. 1771, L. Casella.
Do. No. 725, L. Casella (spare).
Do. No. 1420, L. Casella (spare).

Dry bulb thermometer—No. 94221, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Wet do. No. 94219, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Dry maximum thermometer—No. 8581, Negretti and Zambra.
Dry minimum do. No. 69017, L. Casella.
Wet do. do. No. 91753, Negretti and Zambra.
Sun maximum thermometer—No. 127618, Negretti and Zambra.
Grass minimum thermometer—No. 3377, Negretti and Zambra.
Rain-gauge (8″ diameter)—No. 1042, Negretti and Zambra.
Measure glass for above.
Rain-gauge (5″ diameter).
Measure glass for above.
Stop watch—No. A-3.

The variations in the level of the Transit Circle still continue but have now a much smaller range than in 1915 and previous years before the drain was constructed round the observatory. Further they have now become very nearly periodic, and do not show a net progressive change in one direction for the whole year, as was the case formerly. During the third and fourth week in October there was a rapid recovery in the level but it was only about half of the similar change which occurred in the third week of October in 1916 and one-third of the corresponding sudden change in 1915. The range this year was less than in 1916 and possibly this was due to the better distribution of rainfall this year (see remarks on Rainfall in Weather Summary). The most satisfactory feature however is that the changes are not only smaller but are no longer cumulative. During the first half of January 1917 the mean level error was $+ 0^{s}{\cdot}25$ and during the last half of December 1917 and first half of January 1918 it was $+ 0^{s}{\cdot}19$.

The rate of the Riefler clock has been very steady during the year. If it could be placed in a more favourable position where it would not be subjected to such violent fluctuations of temperatures as it undergoes in its present position, no doubt it would be still more satisfactory.

6. *Weather summary.*—The following is a summary of the meteorological conditions at Madras during 1917 :—

*Pressure.*—The mean monthly pressure was 0·015 inch above normal in January and below normal during the rest of the year, the defect being greatest in the months of October and December—about 0·065 inch. The highest daily mean was 30·150 inches on January 9.

*Temperature.*—The mean temperature of the air was above normal in January and November, below normal in June and September and about the average during the remaining months of the year. The maximum shade temperature was below normal in June, August, September and December and normal during the rest of the year. The highest temperature was recorded on May 25 (105°·3 F.). The minimum in shade was in defect of the average in May and June and in excess in January, February and November. The lowest temperature recorded was 60°·7 on February 19. The highest sun maximum was 164°·1 on February 28 and the lowest on grass was 57°·3 on February 19.

*Humidity.*—The percentage of humidity was above normal from July to September and differed little from normal during the rest of the year. The driest day in the year was June 20, when the humidity was only 31.

*Wind.*—The wind velocity was above normal in January, normal in February and April and below normal throughout the rest of the year. The wind direction was nearly normal in all months except in October when it was 15 points towards west.

*Cloud.*—The weather was more cloudy than usual in February, September and November and less cloudy during the other months.

*Sunshine.*—The percentage of bright sunshine was above normal in April, May and July and below in all other months. The total number of hours of bright sunshine during the year was 2190·9 against 2372·1 in the previous year.

*Rainfall.*—Rainfall was in excess of the average from June to October and in December and in defect during the rest of the year, the greatest excess being 5·48 inches in October and the greatest defect 7·18 inches in November. The total rainfall for the year was 51·06 inches on 101 days. The monsoon rainfall from October 15 to the end of the year was normal and amounted to 26·06 inches. The heaviest rainfall on one day was 6·52 inches on October 20.

*Storm.*—A depression which formed in the Bay about the 15th October, developed and moved in a north-westerly direction, giving heavy rain in the north of the Presidency, and filled up near Nellore about the 22nd October. Another storm which entered the Bay from the east about the middle of November caused squally weather at Madras. Stormy weather was also experienced on the Madras Coast during the beginning of December.

THE OBSERVATORY, MADRAS,
*3rd February* 1918.

R. LL. JONES,
*Deputy Director.*

# APPENDIX I.

## STATION—KODAIKANAL OBSERVATORY.

### SEISMIC RECORDS.

$\phi = 10° 13' 50''$ $\lambda = 77° 28' 00''$ $h$ = 2,343 metres. *Subsoil*—Rock.
*Apparatus*—Milne's Horizontal Pendulum Seismograph.

| 1917. | $T_o$ | $\frac{\tau}{T_o^2}$ | 1917. | $T_o$ | $\frac{\tau}{T_o^2}$ |
|---|---|---|---|---|---|
| January ... . ... | 17·4 | 2·6 | July .. ... ... | 18·1 | 2·8 |
| February ... . ... | 17·2 | 2·6 | August .. ... . | 18·0 | 2·7 |
| March .. ... .. | 17·0 | 2·6 | September ... ... | 17·4 | 2·8 |
| April ... ... ... | 17·2 | 2·6 | October ... ... .. | 17·4 | 2·6 |
| May .. .. . | 17·1 | 2·7 | November .. ... .. | 17·3 | 2·7 |
| June ... ... .. | 17·2 | 2·7 | December ... .. ... | 17·4 | 2·5 |

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period. (Sec.) | Amplitude ($\mu$). An. | Ae. | Az. | Distance $\Delta$ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1917. | | | | | | | | | | |
| 1 | January 4 ... | eP | 17 | 11 | 42 | ... | ... | ... | .. | .. | No record from 6th to 8th. |
| | | eL | 17 | 18 | 00 | .. | ... | ... | ... | ... | |
| | | M | 17 | 22 | 06 | ... | ... | 80 | .. | ... | |
| | | F | 17 | 44 | 00 | ... | ... | . | .. | ... | |
| 2 | 17 ... | eP | 2 | 55 | 24 | ... | . | ... | .. | ... | Widening of line. |
| | | F | 3 | 24 | 54 | . | .. | .. | ... | ... | |
| 3 | 20–21 .. | iP | 23 | 25 | 48 | .. | ... | ... | ... | ... | |
| | | iL | 23 | 32 | 18 | ... | | . | ... | ... | |
| | | M | 23 | 38 | 36 | ... | ... | 250 | ... | ... | |
| | | F | 0 | 41 | 42 | ... | .. | ... | .. | ... | |
| 4 | 24 ... | eP | 1 | 10 | 18 | | .. | .. | ... | . | Widening of line. |
| | | F | 2 | 01 | 00 | ... | ... | ... | ... | ... | |
| 5 | 26 ... | eP | 5 | 55 | 24 | .. | .. | .. | ... | ... | Widening of line. |
| | | F | 6 | 12 | 42 | ... | ... | .. | .. | ... | |
| 6 | 30 ... | eP | 2 | 57 | 48 | ... | ... | . | ... | ... | |
| | | eL | 3 | 07 | 24 | ... | ... | | ... | ... | |
| | | M | 3 | 42 | 12 | ... | ... | 1350 | . | .. | |
| | | F | 7 | 13 | 42 | .. | ... | ... | ... | ... | |
| 7 | 30 ... | eP | 8 | 08 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 8 | 25 | 54 | ... | . | . | ... | ... | |
| 8 | 31 ... | eP | 4 | 08 | 00 | ... | ... | ... | ... | ... | |
| | | iL | 4 | 23 | 00 | ... | ... | ... | ... | .. | |
| | | M | 4 | 33 | 54 | ... | ... | 190 | ... | ... | |
| | | F | 5 | 37 | 06 | ... | .. | ... | ... | ... | |
| 9 | February 12 ... | eP | 9 | 26 | 42 | ... | ... | . | ... | ... | Widening of line. |
| | | F | 10 | 34 | 18 | ... | ... | ... | ... | ... | |
| 10 | 15 ... | eP | 2 | 00 | 00 | ... | ... | ... | ... | ... | |
| | | iL | 2 | 04 | 48 | ... | ... | ... | | ... | |
| | | M | 2 | 34 | 06 | ... | ... | 150 | ... | ... | |
| | | F | 3 | 10 | 12 | ... | .. | ... | ... | ... | |
| 11 | 18 ... | eP | 1 | 38 | 06 | ... | ... | ... | .. | ... | Widening of line. |
| | | F | 2 | 09 | 18 | ... | ... | ... | ... | ... | |
| 12 | 20 ... | eP | 20 | 10 | 30 | ... | ... | ... | ... | . | |
| | | eL | 20 | 42 | 24 | ... | ... | .. | . | ... | |
| | | M | 20 | 58 | 06 | ... | ... | 160 | ... | ... | |
| | | F | 22 | 00 | 24 | . | ... | .. | ... | ... | |
| 13 | 21 ... | eP | 10 | 57 | 18 | ... | .. | ... | ... | ... | Widening of line. |
| | | F | 11 | 44 | 00 | . | ... | ... | ... | ... | |
| 14 | 22 ... | eP | 10 | 27 | 12 | ... | ... | ... | ... | ... | |
| | | eL | 10 | 30 | 30 | ... | ... | ... | ... | ... | |
| | | M | 10 | 32 | 00 | ... | .. | 70 | ... | . | |
| | | F | 11 | 13 | 42 | | ... | ... | ... | .. | |
| 15 | 25 ... | eP | 5 | 39 | 12 | . | ... | ... | .. | ... | Widening of line. |
| | | F | 6 | 44 | 12 | ... | ... | ... | ... | | |
| 16 | March 14 ... | eP | 1 | 15 | 18 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 1 | 25 | 24 | | ... | .. | ... | ... | |
| 17 | 15 ... | eP | 0 | 34 | 06 | | ... | .. | .. | ... | |
| | | eL | 0 | 54 | 12 | ... | ... | . | ... | ... | |
| | | M | 1 | 01 | 00 | ... | ... | 70 | ... | ... | |
| | | F | 2 | 01 | 30 | ... | ... | ... | ... | ... | |
| 18 | 16 ... | eP | 3 | 30 | 18 | ... | ... | .. | ... | ... | Widening of line. |
| | | F | 4 | 04 | 30 | ... | . | ... | .. | ... | |

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period. (Sec.) | Amplitude ($\mu$). An. | Ae. | Az. | Distance. $\triangle$ (Km.) | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1917. | | | | | | | | | | |
| 19 | April 3 ... | eP | 12 | 48 | 12 | ... | ... | ... | ... | ... | |
| | | iL | 12 | 52 | 48 | ... | ... | ... | ... | ... | |
| | | M | 12 | 54 | 00 | ... | ... | 100 | ... | ... | |
| | | F | 13 | 38 | 36 | ... | ... | ... | ... | ... | |
| 20 | 12 ... | eP | 2 | 59 | 12 | ... | ... | ... | ... | ... | |
| | | iL | 3 | 04 | 18 | ... | ... | ... | ... | ... | |
| | | M | 3 | 17 | 42 | ... | ... | 50 | ... | ... | |
| | | F | 3 | 44 | 12 | ... | ... | ... | ... | ... | |
| 21 | 17 ... | eP | 18 | 55 | 42 | ... | ... | ... | ... | ... | |
| | | eL | 18 | 59 | 00 | ... | ... | ... | ... | ... | |
| | | M | 19 | 02 | 30 | ... | ... | 120 | ... | ... | |
| | | F | 19 | 37 | 06 | ... | ... | ... | ... | ... | |
| 22 | 21 ... | P | ... | ... | | ... | ... | ... | ... | ... | No P.Ts. |
| | | iL | 0 | 59 | 30 | ... | ... | ... | ... | ... | |
| | | M | 1 | 05 | 06 | ... | ... | 190 | ... | ... | |
| | | F | 1 | 34 | 06 | ... | ... | ... | ... | ... | |
| 23 | 29 ... | eP | 12 | 13 | 42 | ... | ... | ... | ... | ... | |
| | | iL | 12 | 25 | 12 | ... | ... | ... | ... | ... | |
| | | M | 12 | 30 | 12 | ... | ... | 80 | ... | ... | |
| | | F | 12 | 56 | 24 | ... | ... | ... | ... | ... | |
| 24 | May * 1–2 ... | eP | 18 | 40 | 42 | ... | ... | ... | ... | ... | |
| | | iL | 18 | 54 | 24 | ... | ... | ... | ... | ... | |
| | | M | 19 | 34 | 06 | ... | ... | 1420 | ... | ... | |
| | | F | 0 | 02 | 30 | ... | ... | ... | ... | ... | |
| 25 | 24 ... | eP | 20 | 16 | 12 | ... | ... | ... | ... | ... | |
| | | eL | 20 | 21 | 18 | ... | ... | ... | ... | ... | |
| | | M | 20 | 30 | 30 | ... | ... | 70 | ... | ... | |
| | | F | 20 | 42 | 48 | ... | ... | ... | ... | ... | |
| 26 | 29 ... | eP | 6 | 59 | 12 | ... | ... | ... | ... | ... | |
| | | eL | 7 | 00 | 18 | ... | ... | ... | ... | ... | |
| | | M | 7 | 06 | 24 | ... | ... | 50 | ... | ... | |
| | | F | 7 | 17 | 12 | ... | ... | ... | ... | ... | |
| 27 | 31 ... | eP | 9 | 06 | 24 | ... | ... | ... | ... | ... | |
| | | iL | 9 | 38 | 12 | ... | ... | ... | ... | ... | |
| | | M | 9 | 50 | 48 | ... | ... | 620 | ... | ... | |
| | | F | 9 | 52 | 36 | ... | ... | ... | ... | ... | |
| 28 | June 3 | eP | 14 | 58 | 00 | ... | ... | ... | ... | ... | Widening of line |
| | | F | 15 | 19 | 12 | ... | ... | ... | ... | ... | |
| 29 | 9 ... | eP | 9 | 46 | 00 | ... | ... | ... | ... | ... | |
| | | iL | 9 | 48 | 48 | ... | ... | ... | ... | ... | |
| | | M | 9 | 49 | 36 | ... | ... | 40 | ... | ... | |
| | | F | 10 | 27 | 30 | ... | ... | ... | ... | ... | |
| 30 | 9 ... | eP | 17 | 53 | 36 | ... | ... | ... | ... | ... | |
| | | eL | 18 | 01 | 54 | ... | ... | ... | ... | ... | |
| | | M | 18 | 05 | 24 | ... | ... | 70 | ... | ... | |
| | | F | 18 | 23 | 48 | ... | ... | ... | ... | ... | |
| 31 | 13 ... | eP | 7 | 01 | 30 | ... | ... | ... | ... | ... | |
| | | iL | 7 | 07 | 42 | ... | ... | ... | ... | ... | |
| | | M | 7 | 49 | 42 | ... | ... | 600 | ... | ... | |
| | | F | ...... | | | | ... | ... | ... | ... | |
| 32 | 13 ... | P | ... | | | | ... | ... | ... | ... | |
| | | eL | 9 | 56 | 42 | ... | ... | ... | ... | ... | |
| | | M | 10 | 00 | 12 | ... | ... | 50 | ... | ... | |
| | | F | 10 | 21 | 48 | ... | ... | ... | ... | ... | |
| 33 | 24 ... | eP | 20 | 08 | 00 | ... | ... | ... | ... | ... | |
| | | iL | 20 | 17 | 24 | ... | ... | ... | ... | ... | |
| | | M | 20 | 18 | 12 | ... | ... | 70 | ... | ... | |
| | | F | ...... | | | ... | ... | ... | ... | ... | |
| 34 | 24 . | P | ...... | | | ... | ... | ... | ... | ... | |
| | | iL | 20 | 51 | 18 | ... | ... | ... | ... | ... | |
| | | M | 20 | 58 | 12 | ... | ... | 50 | ... | ... | |
| | | F | 21 | 13 | 06 | ... | ... | ... | ... | ... | |
| 35 | 26 ... | iP | 6 | 04 | 24 | ... | ... | ... | ... | ... | |
| | | iL | 6 | 08 | 42 | ... | ... | ... | ... | ... | |
| | | M1 | 6 | 19 | 36 | ... | ... | 500 | ... | | |
| | | M2 | 6 | 55 | 06 | ... | ... | 700 | ... | ... | |
| | | M3 | 6 | 56 | 42 | ... | ... | 650 | ... | ... | |
| | | M4 | 7 | 02 | 48 | ... | ... | 1080 | ... | ... | |
| | | F | 10 | 48 | 30 | ... | ... | ... | ... | ... | |
| 36 | July 4 ... | eP | 0 | 46 | 48 | ... | ... | ... | ... | ... | |
| | | iL | 0 | 53 | 48 | ... | | ... | ... | ... | |
| | | M | 1 | 13 | 24 | ... | ... | 290 | ... | ... | |
| | | F | 2 | 39 | 12 | ... | ... | ... | ... | ... | |
| 37 | 4 ... | eP | 5 | 52 | 12 | ... | ... | ... | ... | ... | |
| | | eL | 5 | 55 | 12 | ... | ... | ... | ... | ... | |
| | | M | 6 | 11 | 18 | ... | ... | 90 | ... | ... | |
| | | F | 6 | 52 | 36 | ... | ... | ... | ... | ... | |
| 38 | 4 ... | eP | 22 | 20 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 22 | 48 | 06 | ... | | ... | ... | ... | |
| 39 | 15 ... | eP | 11 | 11 | 54 | | ... | ... | ... | ... | Widening of line. |
| | | F | 11 | 36 | 24 | ... | ... | ... | ... | ... | |

* Driving clock removed for repairs May 5 to 19.

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period. (Sec.). | Amplitude ($\mu$). AN. | AE. | AZ. | Distance △ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1917. | | | | | | | | | | |
| 40 | July 15 ... | eP | 18 | 16 | 48 | .. | .. | . | . . | ... | Widening of line. |
| | | F | 18 | 41 | 42 | | . | | . | | |
| 41 | 27 ... | eP | 1 | 24 | 24 | ... | ... | .. | . | ... | |
| | | eL | 2 | 23 | 24 | ... | . | ... | | ... | |
| | | M | 2 | 33 | 06 | ... | .. | 100 | . | .. | |
| | | F | | ... | | ... | .. | ... | ... | | |
| 42 | 27 ... | P | | . | | ... | ... | . | ... | ... | Overlapping. |
| | | iL | 4 | 00 | 54 | .. | ... | ... | .. | ... | |
| | | M | 4 | 12 | 36 | .. | ... | 340 | .. | ... | |
| | | F | 5 | 10 | 00 | ... | ... | ... | ... | . | Instrument examined at $5^h$ $2^m$. |
| 43 | 29 ... | iP | 14 | 52 | 18 | .. | .. | ... | ... | ... | |
| | | iL | 15 | 13 | 18 | ... | ... | | ... | ... | |
| | | M | 15 | 15 | 06 | ... | ... | 110 | .. | ... | |
| | | F | 16 | 17 | 12 | .. | . . | ... | ... | ... | |
| 44 | 29-30 ... | iP | 22 | 02 | 42 | ... | ... | ... | ... | ... | |
| | | iL | 22 | 11 | 24 | ... | ... | | . . | ... | |
| | | M | 22 | 45 | 36 | ... | ... | 520 | ... | ... | |
| | | F | 1 | 38 | 12 | .. | . | . | | ... | |
| 45 | 31 ... | eP | 0 | 05 | 30 | ... | ... | | ... | ... | |
| | | iL | 0 | 13 | 24 | ... | ... | ... | ... | ... | |
| | | M | 0 | 19 | 18 | ... | ... | 290 | | . . | |
| | | F | 1 | 37 | 42 | ... | . . | ... | ... | ... | |
| 46 | August 3 .. | eP | 21 | 49 | 24 | . . | ... | ... | ... | ... | |
| | | iL | 21 | 53 | 30 | ... | ... | | .. | .. | |
| | | M | 21 | 54 | 30 | ... | ... | 80 | ... | ... | |
| | | F | 22 | 05 | 12 | ... | ... | ... | ... | ... | |
| 47 | 5 ... | eP | 16 | 36 | 36 | ... | ... | ... | ... | ... | |
| | | eL | 16 | 47 | 06 | | ... | ... | ... | ... | |
| | | M | 16 | 54 | 48 | ... | ... | 130 | ... | ... | |
| | | F | 18 | 06 | 48 | ... | | ... | .. | ... | |
| 48 | 30 . | P | | .. | | ... | ... | ... | ... | ... | No P.Ts. |
| | | iL | 4 | 16 | 30 | ... | ... | ... | ... | ... | |
| | | M | 4 | 42 | 18 | ... | | ... | ... | ... | |
| | | F | 6 | 32 | 30 | ... | ... | ... | ... | ... | |
| 49 | 31 ... | eP | 11 | 56 | 42 | ... | .. | ... | | .. | |
| | | eL | 13 | 01 | 48 | ... | ... | . | | ... | |
| | | M | 13 | 05 | 24 | ... | ... | 170 | ... | ... | |
| | | F | 14 | 05 | 54 | ... | | ... | ... | ... | |
| 50 | September 15 ... | eP | 10 | 07 | 42 | ... | ... | ... | ... | . | Widening of line. |
| | | F | 10 | 19 | 30 | .. | ... | .. | | ... | |
| 51 | 17 ... | P | | . | | ... | .. | ... | ... | ... | No P.Ts. |
| | | eL | 20 | 18 | 00 | | ... | ... | ... | ... | |
| | | M | 20 | 20 | 12 | ... | ... | 50 | ... | ... | |
| | | F | 20 | 25 | 54 | ... | ... | | ... | ... | |
| 52 | 20 ... | eP | 3 | 39 | 24 | ... | ... | ... | .. | ... | Widening of line. |
| | | F | 4 | 05 | 18 | ... | ... | | ... | ... | |
| 53 | 26 ... | eP | 22 | 13 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 22 | 14 | 36 | | .. | | ... | ... | |
| 54 | October 17 ... | eP | 1 | 17 | 32 | ... | .. | ... | . | ... | Widening of line. |
| | | F | 1 | 44 | 18 | | ... | .. | ... | ... | |
| 55 | 19 ... | eP | 18 | 12 | 54 | .. | ... | ... | ... | ... | Widening of line. |
| | | F | 18 | 23 | 06 | ... | ... | ... | ... | ... | |
| 56 | 22 ... | P | | . | | ... | ... | | ... | ... | No P.Ts. |
| | | eL | 8 | 53 | 18 | .. | | ... | ... | ... | |
| | | M | 8 | 56 | 36 | . | ... | 50 | ... | ... | |
| | | F | 9 | 02 | 30 | ... | ... | ... | ... | ... | |
| 57 | 29 .. | eP | 21 | 34 | 06 | ... | .. | .. | ... | ... | Widening of line. |
| | | F | 21 | 38 | 36 | ... | ... | ... | ... | .. | |
| 58 | November 4 ... | iP | 12 | 09 | 30 | ... | ... | ... | ... | ... | |
| | | iL | 12 | 12 | 54 | ... | ... | ... | ... | ... | |
| | | M | 12 | 18 | 12 | ... | ... | 1320 | ... | ... | |
| | | F | 13 | 29 | 12 | ... | ... | ... | .. | ... | |
| 59 | 14 .. | eP | 5 | 36 | 42 | | .. | ... | ... | ... | Widening of line. |
| | | F | 5 | 38 | 12 | ... | ... | ... | ... | ... | |
| 60 | 16 ... | eP | 3 | 38 | 12 | ... | ... | ... | ... | ... | |
| | | iL | 3 | 47 | 54 | ... | ... | ... | .. | . | |
| | | M | 4 | 27 | 42 | .. | ... | 800 | ... | ... | |
| | | F | 6 | 26 | 42 | ... | ... | ... | ... | ... | |
| 61 | 16 ... | eP | 22 | 27 | 12 | ... | ... | . . | ... | ... | |
| | | iL | 22 | 33 | 06 | ... | ... | ... | ... | ... | |
| | | M | 22 | 47 | 24 | ... | ... | 50 | ... | ... | |
| | | F | 23 | 11 | 36 | ... | ... | ... | ... | ... | |
| 62 | 18 ... | eP | 3 | 07 | 00 | ... | ... | .. | ... | ... | Light stopped from $3^h$ $9{\cdot}5^m$ to $3^h$ $11{\cdot}5^m$ for marking time on sheet. |
| | | L | | ... | | ... | ... | ... | ... | ... | |
| | | M | 3 | 12 | 54? | ... | ... | 320 | ... | ... | |
| | | F | 4 | 09 | 06 | ... | ... | ... | ... | ... | |

| No. | Date. | Phase. | Time G M.T. | | | Period. (Sec.). | Amplitude ($u$). | | | Distance $\triangle$ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | An. | Ae. | Az. | | |
| | 1917. | | H. | M. | S. | | | | | | |
| 63 | November 24 ... | eP | 11 | 47 | 12 | ... | ... | ... | .. | ... | Widening of line. |
| | | F | 11 | 53 | 30 | ... | ... | | ... | ... | |
| 64 | 28 ... | eP | 15 | 01 | 48 | .. | ... | | ... | .. | Widening of line. |
| | | F | 15 | 12 | 36 | ... | .. | ... | ... | ... | |
| 65 | December 1 ... | eP | 9 | 57 | 48 | ... | ... | ... | ... | ... | |
| | | eL | 10 | 01 | 12 | ... | ... | . | ... | ... | |
| | | M | 10 | 02 | 42 | .. | ... | 40 | | .. | |
| | | F | 10 | 08 | 18 | ... | ... | | ... | ... | |
| 66 | 5 ... | eP | 13 | 07 | 06 | ... | ... | ... | .. | ... | Widening of line. |
| | | F | 13 | 13 | 18 | ... | ... | .. | .. | ... | |
| 67 | 19 ... | eP | 10 | 01 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 10 | 05 | 06 | ... | ... | ... | ... | . | |
| 68 | 20 ... | P | | .. | | ... | ... | ... | ... | ... | No P.Ts. |
| | | eL | 2 | 56 | 00 | ... | ... | . | .. | ... | |
| | | M | 3 | 00 | 36 | ... | ... | 90 | ... | ... | |
| | | F | 3 | 12 | 24 | ... | .. | ... | .. | ... | |
| 69 | 21 ... | eP | 18 | 19 | 12 | | .. | ... | ... | .. | |
| | | eL | 18 | 50 | 30 | .. | ... | | .. | ... | |
| | | M | 19 | 00 | 48 | ... | ... | 200 | ... | ... | |
| | | F | 20 | 21 | 18 | ... | | ... | ... | ... | |
| 70 | 21 ... | eP | 21 | 51 | 06 | .. | ... | . | .. | . | Widening of line. |
| | | F | 21 | 54 | 42 | .. | .. | ... | ... | . | |
| 71 | 28 .. | P | | ... | | ... | ... | | .. | .. | No P.Ts. |
| | | eL | 22 | 10 | 00 | ... | ... | .. | ... | ... | |
| | | M | 22 | 19 | 24 | . | ... | 90 | ... | ... | |
| | | F | 22 | 43 | 18 | ... | | .. | .. | .. | |
| 72 | 29–30 ... | eP | 23 | 28 | 00 | ... | ... | | .. | ... | |
| | | eL | 0 | 25 | 06 | . | ... | | | ... | |
| | | M | 0 | 43 | 06 | ... | ... | 150 | ... | ... | |
| | | F | 1 | 05 | 24 | | ... | ... | ... | ... | |

# APPENDIX II.

Latitude 10° 13′ 50″ N.

Longitude $5^h\ 9^m\ 52^s$ E.

Height of Barometer cistern above mean sea level 7,688 feet.

## MEAN Monthly and Annual Meteorological Results at the Kodaikanal Observatory in 1917.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily Range. | Dry Bulb Thermometer. Mean. | Dry Bulb Thermometer. Max. | Dry Bulb Thermometer. Min. | Dry Bulb Thermometer. Range. | Wet Bulb. Mean. | Wet Bulb. Min. | Tension of Vapour. By Simpson's Tables. | Relative Humidity. By Simpson's Tables. | Sun Max. in Vac. | Min. on Grass. | Wind. Daily Velocity | Wind. Mean Direction. | Wind. Mean Direction. | Rain Amount. | Rain Days. | Clear Sky. | Bright Sun shine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Inches. | ° | ° | ° | ° | ° | ° | Inches. | Cents. | ° | ° | Miles. | Points | Points. | Inches. | No. | Cents. | Hours. |
| January | 22·835 | 0·059 | 52·7 | 60·6 | 44·9 | 15·7 | 46·8 | 40·8 | 0·273 | 71 | 113·7 | 39·1 | 379 | | E. by S. | 1·49 | 3 | 48 | 218·1 |
| February | ·823 | ·063 | 55·5 | 64·3 | 46·7 | 17·6 | 48·7 | 42·6 | ·285 | 67 | 123·9 | 41·3 | 276 | 4 | N. E. | 6·52 | 5 | 59 | 232·7 |
| March | ·823 | ·063 | 58·1 | 67·1 | 49·0 | 18·1 | 50·3 | 44·6 | ·299 | 64 | 131·3 | 43·8 | 267 | 2 | N. N. E. | 2·13 | 5 | 54 | 241·6 |
| April | ·819 | ·056 | 61·3 | 70·8 | 51·8 | 19·0 | 53·2 | 47·1 | ·336 | 64 | 135·4 | 44·9 | 257 | 4 | N. E. | 2·03 | 4 | 54 | 255·6 |
| May | ·813 | ·061 | 60·3 | 68·4 | 52·1 | 16·3 | 53·5 | 48·3 | ·348 | 69 | 133·6 | 46·1 | 225 | 16 | South | 7·00 | 7 | 54 | 238·7 |
| June | ·741 | ·056 | 58·8 | 64·5 | 53·0 | 11·5 | 54·4 | 50·0 | ·389 | 80 | 124·7 | 49·7 | 325 | 24 | West | 7·65 | 12 | 17 | 106·3 |
| July | ·746 | ·050 | 58·5 | 64·6 | 52·4 | 12·2 | 54·1 | 49·8 | ·384 | 80 | 125·5 | 49·1 | 322 | 23 | W. by S | 3·31 | 5 | 23 | 135·1 |
| August | ·757 | ·063 | 58·1 | 63·6 | 52·6 | 11·0 | 55·1 | 50·9 | ·412 | 87 | 120·8 | 49·3 | 196 | 24 | West | 11·54 | 16 | 21 | 115·2 |
| September | ·754 | ·074 | 57·6 | 63·2 | 52·1 | 11·1 | 54·4 | 50·6 | ·401 | 88 | 121·7 | 49·1 | 214 | 22 | W. S. W. | 10·77 | 22 | 17 | 95·0 |
| October | ·763 | ·067 | 56·8 | 63·7 | 49·9 | 13·8 | 51·0 | 45·5 | ·329 | 73 | 121·7 | 45·6 | 258 | 27 | N. W. by W. | 3·96 | 7 | 41 | 201·9 |
| November | ·810 | ·060 | 55·2 | 61·1 | 49·3 | 11·8 | 52·1 | 47·9 | ·369 | 87 | 111·8 | 46·0 | 254 | 1 | N. by E. | 10·24 | 15 | 27 | 133·2 |
| December | ·792 | ·066 | 54·4 | 62·4 | 46·3 | 16·1 | 48·2 | 42·2 | ·288 | 70 | 118·9 | 39·5 | 248 | 31 | N. by W. | 0·81 | 3 | 49 | 215·0 |
| Annual | 22·790 | 0·061 | 57·3 | 64·5 | 50·0 | 14·5 | 51·8 | 46·7 | 0·343 | 75 | 123·6 | 45·3 | 268 | 29 | N. W. by N. | 67·45 | 104 | 39 | 2188·4 |

## EXTREME Monthly Meteorological Records at the Kodaikanal Observatory in 1917.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry Bulb Thermometer. Highest. | | Dry Bulb Thermometer. Lowest. | | Wet Bulb. Lowest. | | Humidity. Lowest. | | Sun Th. in Vacuo. Highest. | | Grass Therm. Lowest. | | Wind Highest. | | Wind Lowest. | | Rain. Greatest Fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Day. | Inches. | Day. | Inches. | ° | Day. | ° | Day | ° | Day. | Cents. | Day. | ° | Day. | ° | Day. | Miles. | Day. | Miles. | Day. | Inches. | Day. |
| January | 22·928 | 11 | 22·754 | 29, 30 | 0·174 | 71·3 | 21 | **37·1** | **6** | **32·8** | **22** | 12 | 22 | 139·9 | 20 | **28·1** | **29** | **820** | **31** | 114 | 2 | 0·64 | 12 |
| February | **·940** | **13** | ·721 | 26, 28 | ·219 | 70·5 | 20 | 43·1 | 15 | 33·3 | 16 | **9** | **18** | 140·9 | 26 | 35·1 | 11, 16 | 590 | 1 | 134 | 27 | **3·13** | **1** |
| March | ·930 | 29 | ·719 | 3 | ·211 | 71·3 | 6 | 42·3 | 4 | 34·2 | 4 | 16 | 4 | 142·3 | 20 | 36·1 | 4 | 410 | 3 | 155 | 23 | 0·63 | 25 |
| April | ·872 | 26 | ·733 | 30 | ·139 | **77·2** | **13** | 47·4 | 8 | 40·5 | 28 | 27 | 28 | 148·9 | 13 | 38·3 | 5 | 422 | 29 | 151 | 20 | 0·70 | 23 |
| May | ·894 | 24 | ·685 | 1 | ·209 | 72·6 | 12 | 48·2 | 5 | 37·1 | 5 | 29 | 4 | 141·9 | 11 | 38·1 | 5 | 340 | 22 | 118 | 3 | 1·73 | 30 |
| June | ·825 | 17 | ·646 | 14 | ·179 | 67·9 | 13 | 49·7 | 20 | 44·4 | 22 | 51 | 11 | **160·9** | **8** | 46·0 | 12 | 556 | 27 | 182 | 16 | 1·79 | 2 |
| July | ·812 | 3 | ·661 | 19 | ·151 | 67·8 | 2 | 50·2 | 20 | 44·2 | 10 | 45 | 10 | 142·6 | 2 | 44·0 | 4 | 655 | 19 | 115 | 6 | 1·71 | 5 |
| August | ·866 | 25 | **·645** | **20** | ·221 | 66·7 | 2 | 50·5 | 28 | 46·9 | 2 | 55 | 26 | 135·0 | 9 | 45·0 | 3 | 435 | 27 | 129 | 25 | 1·58 | 15 |
| September | ·823 | 20 | ·678 | 5 | ·145 | 69·5 | 28 | 50·2 | 12 | 48·1 | 9 | 61 | 18 | 155·8 | 28 | 46·6 | 23 | 430 | 29 | **112** | **20** | 1·66 | 20 |
| October | ·861 | 14 | ·658 | 18 | ·203 | 67·2 | 14 | 46·6 | 29 | 33·8 | 31 | 14 | 31 | 138·9 | 12 | 36·9 | 29 | 410 | 4 | 145 | 11 | 1·08 | 19 |
| November | ·894 | 30 | ·709 | 12 | ·185 | 66·6 | 3, 4 | 43·7 | 30 | 38·2 | 1, 30 | 40 | 1 | 130·7 | 3 | 37·0 | 1 | 468 | 7 | 130 | 19 | 1·51 | 30 |
| December | ·892 | 1 | ·712 | 27 | ·180 | 69·5 | 30 | 41·8 | 27 | 34·8 | 28 | **9** | **17** | 129·9 | 4 | 28·6 | 16 | 356 | 15 | 119 | 4 | 0·26 | 14 |

# APPENDIX III.

KODAIKANAL mean hourly wind velocity for the year 1917.

| Month. | Hours | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| January | 18 | 16 | 15 | 17 | 17 | 17 | 17 | 17 | 17 | 20 | 18 | 15 | 17 | 16 | 14 | 14 | 11 | 11 | 14 | 15 | 14 | 16 | 16 | 16 |
| February | 12 | 12 | 13 | 13 | 14 | 13 | 14 | 14 | 13 | 14 | 14 | 13 | 13 | 11 | 10 | 10 | 9 | 9 | 9 | 9 | 9 | 10 | 11 | 11 |
| March | 12 | 12 | 12 | 12 | 12 | 11 | 13 | 12 | 12 | 14 | 14 | 13 | 12 | 11 | 10 | 10 | 9 | 8 | 8 | 8 | 9 | 10 | 11 | 12 |
| April | 10 | 11 | 11 | 11 | 12 | 11 | 11 | 11 | 11 | 13 | 13 | 13 | 11 | 11 | 12 | 12 | 10 | 9 | 9 | 10 | 9 | 8 | 9 | 10 |
| May | 9 | 9 | 9 | 9 | 9 | 9 | 8 | 8 | 9 | 10 | 11 | 12 | 11 | 11 | 11 | 10 | 9 | 8 | 9 | 9 | 9 | 9 | 9 | 9 |
| June | 15 | 16 | 16 | 15 | 15 | 15 | 14 | 14 | 12 | 12 | 11 | 12 | 11 | 11 | 12 | 12 | 12 | 13 | 15 | 14 | 14 | 15 | 15 | 15 |
| July | 15 | 15 | .16 | 16 | 16 | 14 | 15 | 14 | 12 | 12 | 11 | 10 | 11 | 10 | 10 | 12 | 12 | 14 | 14 | 15 | 14 | 16 | 15 | 15 |
| August | 9 | 9 | 9 | 9 | 10 | 9 | 9 | 8 | 6 | 6 | 8 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 8 | 9 | 8 | 9 | 10 | 9 |
| September | 11 | 10 | 9 | 10 | 9 | 10 | 10 | 10 | 8 | 9 | 8 | 9 | 8 | 8 | 7 | 8 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 10 |
| October | 12 | 13 | 12 | 12 | 12 | 12 | 12 | 11 | 11 | 10 | 10 | 9 | 10 | 10 | 10 | 9 | 9 | 9 | 10 | 11 | 11 | 11 | 11 | 11 |
| November | 11 | 10 | 11 | 12 | 12 | 12 | 12 | 12 | 11 | 11 | 11 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 11 |
| December | 13 | 12 | 12 | 12 | 12 | 11 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 9 | 8 | 8 | 7 | 8 | 9 | 10 | 11 | 12 | 12 | 13 |
| Mean | 12 | 12 | 12 | 12 | 13 | 12 | 12 | 12 | 11 | 12 | 12 | 11 | 11 | 10 | 10 | 10 | 9 | 9 | 10 | 11 | 11 | 11 | 12 | 12 |

## APPENDIX IV.

KODAIKANAL mean hourly bright sunshine for the year 1917.

| Month. | Hours. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6–7 | 7–8 | 8–9 | 9–10 | 10–11 | 11–12 | 12–13 | 13–14 | 14–15 | 15–16 | 16–17 | 17–18 |
| January | 0·31 | 0·61 | 0·65 | 0·73 | 0·76 | 0·69 | 0·75 | 0·64 | 0·58 | 0·63 | 0·50 | 0·21 |
| February | ·50 | ·76 | ·82 | ·87 | ·86 | ·79 | ·73 | ·72 | ·67 | ·61 | ·57 | 41 |
| March | ·53 | ·80 | ·90 | ·91 | ·90 | ·83 | ·65 | ·56 | ·50 | ·49 | ·41 | ·32 |
| April | 64 | ·88 | ·97 | ·93 | ·91 | ·90 | ·79 | 69 | ·61 | ·55 | ·38 | ·27 |
| May | ·56 | ·77 | ·92 | ·94 | ·90 | ·78 | ·65 | ·56 | ·48 | ·38 | ·43 | ·32 |
| June | ·16 | ·39 | ·37 | ·48 | ·48 | ·40 | ·35 | ·29 | ·27 | ·19 | ·11 | ·05 |
| July | ·16 | ·47 | ·57 | ·59 | ·64 | ·50 | ·43 | ·39 | ·26 | ·23 | ·11 | ·02 |
| August | ·24 | ·49 | ·58 | ·66 | ·58 | ·41 | ·32 | ·25 | ·10 | ·05 | ·02 | 01 |
| September | ·16 | ·42 | ·61 | ·46 | ·43 | ·37 | ·24 | ·14 | ·17 | ·09 | ·08 | ·01 |
| October | ·21 | ·60 | ·66 | ·70 | ·70 | ·70 | ·58 | ·54 | ·52 | ·5 4 | ·48 | ·27 |
| November | ·20 | ·52 | ·60 | ·63 | ·54 | ·46 | ·39 | ·33 | ·33 | ·27 | ·12 | ·03 |
| December | ·25 | ·68 | 77 | ·72 | ·70 | ·70 | ·61 | ·65 | ·67 | ·60 | ·49 | ·09 |
| Mean | 0·33 | ·062 | 0·70 | 0·72 | 0·70 | 0 63 | 0·54 | 0·48 | 0·43 | 0·39 | 0·31 | 0·17 |

## APPENDIX V.

NUMBER of days in each month on which the Nilgiris were visible in 1917.

| Month. | Very clear. | Visible. | Just visible | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January | · | 9 | 4 | 1 | 14 |
| February | | 9 | | · | 12 |
| March | ... | 2 | 4 | ... | 6 |
| April | | ... | 1 | ... | 1 |
| May | 2 | 4 | 1 | . . | 7 |
| June | 8 | 4 | ... | ... | 12 |
| July | | 1 | 3 | ... | 4 |
| August | 3 | 10 | 1 | ... | 14 |
| September | 2 | 4 | .. | ... | 6 |
| October | 3 | 7 | ... | ... | 10 |
| November | ... | 5 | 1 | ... | 6 |
| December | ... | 10 | 1 | 2 | 13 |
| Total | 18 | 65 | 19 | 3 | 105 |

# APPENDIX VI.

## MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1917.

| Abnormals of | January. | February. | March. | April. | May. | June. | July. | August. | September | October. | November. | December. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure ... ... ... | + 0·015 | − 0·032 | − 0·020 | − 0·026 | − 0·041 | − 0·016 | − 0·033 | − 0·027 | − 0·040 | − 0·066 | − 0·047 | − 0·067 | − 0·026 |
| Temperature of air ... ... ... ... | + 1·1 | + 0·7 | + 0·5 | + 0·4 | − 0·4 | − 2·0 | + 0·4 | − 0·2 | − 1·1 | + 0·5 | + 1·5 | − 0·4 | + 0·1 |
| Do. of evaporation ... ... .. | + 0·1 | + 0·4 | − 0·1 | + 0·5 | − 0·9 | + 1·0 | + 1·7 | + 2·0 | + 1·2 | + 0·5 | + 2·1 | − 0·2 | + 0·7 |
| Percentage of humidity .. ... ... | − 4 | − 1 | − 3 | same as | − 2 | + 10 | + 6 | + 9 | + 10 | + 1 | + 3 | + 1 | + 3 |
| Greatest solar heat in vacuo ... .. ... | + 11·1 | + 11·9 | + 14·0 | + 13·6 | + 9·7 | − 0·4 | + 5·7 | + 5·0 | + 7·0 | + 9·6 | + 4·9 | + 9·5 | + 8·4 |
| Maximum in shade ... ... .. . | − 0·8 | − 0·8 | + 0·1 | + 0·2 | − 0·8 | − 3·8 | − 0·5 | − 1·6 | − 3·2 | same as | same as | − 1·0 | − 1·0 |
| Minimum in shade .. ... ... ... ... | + 1·7 | + 1·5 | − 0·3 | + 0·5 | − 1·2 | − 1·9 | + 0·2 | − 0·2 | − 0·5 | + 0·1 | + 2·0 | − 0·8 | + 0·1 |
| Do. on grass ... ... .. | + 2·4 | + 2·9 | + 0·6 | + 1·4 | − 1·0 | − 1·1 | + 0·8 | + 0·9 | + 0·2 | + 1·0 | + 3·1 | − 0·2 | + 1·3 |
| Rainfall in inches .. ... ... .. .. | − 0·51 | − 0·22 | − 0·39 | − 0·62 | − 1·50 | + 3·42 | + 0·34 | + 1·83 | + 0·61 | + 5·48 | − 7·18 | + 0·78 | . |
| Do. since January 1st ... ... ... | ... | − 0·73 | − 1·12 | − 1·74 | − 3·24 | + 0·18 | + 0·52 | + 2·35 | + 2·96 | + 8·44 | + 1·26 | + 2·04 | + 2·04 |
| General direction of wind .. .. . ... | same as | same as | 2 points E. | same as | 1 point E. | same as | 1 point S. | same as | 1 point S. | 15 points W. | same as | 1 point N. | same as |
| Daily velocity in miles ... ... . ... | + 24 | + 6 | − 24 | − 5 | − 40 | − 85 | − 50 | − 46 | − 54 | − 19 | − 18 | − 24 | − 26 |
| Percentage of cloudy sky ... ... ... ... | − 3 | + 5 | same as | − 11 | − 13 | + 3 | − 3 | − 6 | + 5 | − 8 | + 3 | − 3 | − 3 |
| Do of bright sunshine .. .. | − 2·6 | − 4·0 | − 6·2 | + 5·1 | + 1·0 | − 11·1 | + 19·5 | − 7·4 | − 10·8 | − 2·4 | − 7·7 | − 3·8 | − 8·7 |

+ means *above* normal : − means *below* normal.

## APPENDIX VII.

ABSTRACT of the Mean Meteorological Condition of Madras in the year 1917 compared with the average of past years.

| Mean values of | 1917. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure ... ... ... ... | 29·838 | 0·026 below. | 29·864 |
| Temperature of air ... ... ... ... ... ... | 81·2 | 0·1 above. | 81·1 |
| Do. of evaporation ... ... ... ... ... | 75·2 | 0·7 „ | 74·5 |
| Percentage of humidity ... ... ... ... ... ... | 75 | 3 „ | 72 |
| Greatest solar heat in vacuo ... ... ... ... ... | 148·1 | 8·4 „ | 139·7 |
| Maximum in shade .. ... ... ... ... ... | 89·8 | 1·0 below. | 90·8 |
| Minimum in shade ... ... ... ... ... ... | 74·8 | 0·1 above. | 74·7 |
| Do. on grass ... ... ... .. ... ... | 73·2 | 1·3 „ | 71·9 |
| Rainfall since January 1st on 101 days ... ... ... | 51·06 | 2·04 „ | 49·02 |
| General direction of wind . ... ... ... ... | S.E | same as | S.E. |
| Daily velocity in miles ... ... ... ... ... ... | 145 | 26 below. | 171 |
| Percentage of cloudy sky ... ... ... .. ... | 46 | 3 „ | 49 |
| Do. of bright sunshine ... ... ... ... ... | 49·7 | 8·7 „ | 58·4 |

DURATION and Quantity of the Wind from different points.

| From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North. | 337 | 2,299 | East. | 257 | 1,128 | South. | 142 | 933 | West. | 249 | 1,570 |
| N. by E. | 229 | 1,434 | E. by S. | 235 | 1,206 | S. by W. | 242 | 1,707 | W. by N. | 224 | 1,252 |
| NNE. | 213 | 1,657 | ESE. | 348 | 1,504 | SS. W. | 211 | 1,280 | W. N. W. | 69 | 396 |
| NE. by N. | 413 | 3,135 | SE. by E. | 608 | 3,131 | SW. by S. | 275 | 1,595 | N. W. by W | 111 | 515 |
| N.E. | 285 | 2,220 | SE. | 522 | 3,094 | S. W. | 171 | 1,014 | NW. | 75 | 314 |
| NE by E. | 233 | 1,588 | SE. by S. | 572 | 4,326 | SW. by W. | 201 | 1,093 | NW. by N. | 143 | 958 |
| ENE. | 165 | 1,034 | SSE. | 447 | 3,596 | WSW. | 249 | 1,486 | NNW. | 171 | 1,067 |
| E. by N. | 251 | 1,113 | S. by E. | 323 | 2,156 | W. by S. | 340 | 1,983 | N. by W | 165 | 1,177 |

There were 234 calm hours during the year. The resultant corresponding to the above numbers is represented by a SE. by E. wind, blowing with a uniform daily velocity of 30 miles.

# APPENDIX VIII.

MADRAS OBSERVATORY—Number of hours of wind from each point in the year 1917.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S . | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | .. | 19 | 73 | 154 | 111 | 84 | 38 | 49 | 76 | 57 | 38 | 25 | ... | .. | . | ... | . | .. | .. | .. | | ... | | . | ... | ... | ... | ... | ... | ... | ... | ... | 20 |
| February | 4 | 20 | 6 | 46 | 49 | 48 | 49 | 69 | 21 | 33 | 76 | 83 | 76 | 33 | 18 | 2 | ... | . | 1 | 1 | 1 | 3 | .. | .. | .. | ... | .. | ... | ... | ... | ... | ... | 33 |
| March | .. | .. | .. | 27 | 20 | 18 | 37 | 34 | 91 | 49 | 89 | 127 | 117 | 74 | 9 | 8 | 2 | 4 | 2 | 1 | ... | .. | ... | .. | ... | . | . | ... | .. | ... | ... | ... | 35 |
| April | ... | .. | ... | . | .. | .. | . | 2 | 12 | 6 | 25 | 83 | 87 | 179 | 166 | 68 | 26 | 28 | 15 | 6 | 1 | 1 | ... | 1 | ... | ... | ... | ... | ... | ... | ... | .. | 14 |
| May | 4 | | 2 | 5 | 8 | 4 | 2 | 2 | 4 | 8 | 24 | 75 | 105 | 119 | 107 | 58 | 32 | 32 | 26 | 25 | 8 | 13 | 17 | 11 | 6 | 6 | 3 | 7 | 9 | 3 | 10 | 2 | 7 |
| June | 1 | | . | | 1 | 4 | 2 | 1 | 10 | 10 | 3 | 9 | 11 | 23 | 45 | 81 | 24 | 60 | 40 | 65 | 47 | 29 | 38 | 56 | 51 | 38 | 12 | 37 | 7 | 7 | 3 | 1 | 4 |
| July | 4 | . | . | .. | 1 | | 6 | 4 | 18 | 6 | 19 | 39 | 35 | 38 | 30 | 33 | 23 | 41 | 37 | 67 | 35 | 35 | 65 | 69 | 46 | 32 | 16 | 11 | 6 | 9 | 6 | 8 | 5 |
| August | 6 | .. | ... | 2 | 2 | 1 | .. | 22 | 4 | 4 | 6 | 33 | 39 | 21 | 43 | 8 | 15 | 84 | 59 | 53 | 37 | 35 | 45 | 65 | 36 | 29 | 23 | 29 | 8 | 23 | 5 | 4 | 3 |
| September | 15 | ... | 2 | 7 | 2 | 2 | 1 | 9 | 6 | 16 | 50 | 73 | 44 | 47 | 25 | 18 | 8 | 34 | 9 | 47 | 28 | 54 | 43 | 67 | 27 | 18 | 14 | 3 | 12 | 2 | | 1 | 36 |
| October | 24 | 1 | 1 | . | 1 | 2 | 8 | 13 | 9 | 45 | 18 | 40 | 2 | 2 | 2 | 46 | 11 | 8 | 22 | 10 | 10 | 26 | 38 | 71 | 82 | 93 | 1 | 21 | 13 | 23 | 35 | 16 | 50 |
| November | 105 | 75 | 34 | 85 | 68 | 32 | 8 | 28 | 6 | 1 | . | 21 | 6 | 36 | 2 | 1 | 1 | 1 | .. | | 4 | 5 | 3 | . | 1 | 8 | ... | 3 | 20 | 59 | 32 | 50 | 25 |
| December | 174 | 114 | 95 | 87 | 22 | 38 | 14 | 18 | ... | .. | ... | | .. | | .. | . | . | ... | | ... | .. | ... | ... | ... | ... | . | .. | ... | .. | 17 | 80 | 83 | 2 |
| Annual total. | 337 | 229 | 213 | 413 | 285 | 233 | 165 | 251 | 257 | 235 | 348 | 608 | 522 | 572 | 447 | 323 | 142 | 242 | 211 | 275 | 171 | 201 | 249 | 340 | 249 | 224 | 69 | 111 | 75 | 143 | 171 | 165 | 234 |

# APPENDIX IX.

MADRAS OBSERVATORY.—Number of miles of wind from each point in the year 1917.

| Month | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | .. | 202 | 695 | 1,330 | 977 | 555 | 316 | 298 | 323 | 336 | 131 | 77 | . | ... | . | .. | .. | ... | ... | ... | ... | .. | ... | ... | ... | ... | ... | .. | .. | ... | | .. | 5,240 |
| February | 38 | 115 | 21 | 281 | 532 | 365 | 332 | 267 | 124 | 103 | 279 | 425 | 348 | 182 | 127 | 15 | ... | ... | 8 | 6 | 8 | 9 | ... | ... | ... | ... | ... | ... | .. | ... | . | | 3,585 |
| March | . | | | 186 | 128 | 151 | 143 | 163 | 369 | 295 | 422 | 703 | 655 | 519 | 85 | 45 | 11 | 28 | 17 | 7 | .. | ... | ... | ... | ... | ... | ... | ... | .. | .. | . | .. | 3,927 |
| April | | | ... | .. | .. | . | ... | 13 | 29 | 45 | 125 | 377 | 614 | 1,684 | 1,402 | 559 | 234 | 283 | 141 | 54 | 9 | 9 | ... | 7 | . | ... | ... | ... | ... | ... | ... | ... | 5,585 |
| May | 31 | | 10 | 40 | 79 | 45 | 25 | 20 | 35 | 53 | 123 | 501 | 719 | 1,067 | 1,016 | 440 | 194 | 249 | 221 | 219 | 63 | 87 | 106 | 62 | 55 | 48 | 33 | 74 | 75 | 17 | 72 | 12 | 5,791 |
| June | 6 | . | | . | 2 | 38 | 15 | 11 | 76 | 80 | 10 | 52 | 95 | 168 | 374 | 486 | 169 | 363 | 259 | 403 | 279 | 193 | 249 | 363 | 406 | 267 | 81 | 117 | 34 | 22 | 26 | 8 | 4,652 |
| July | 27 | ... | ... | ... | 6 | .. | 41 | 25 | 70 | 45 | 111 | 256 | 217 | 266 | 210 | 231 | 124 | 207 | 181 | 352 | 222 | 202 | 425 | 477 | 358 | 259 | 111 | 65 | 38 | 30 | 14 | 11 | 4,581 |
| August | 51 | . | ... | 14 | 14 | 4 | | 84 | 15 | 28 | 43 | 199 | 259 | 151 | 246 | 86 | 101 | 396 | 291 | 286 | 203 | 163 | 215 | 347 | 208 | 158 | 112 | 109 | 47 | 97 | 21 | 24 | 3,972 |
| September | 35 | ... | 9 | 38 | 16 | 14 | 8 | 21 | 28 | 65 | 187 | 316 | 152 | 190 | 111 | 82 | 47 | 137 | 55 | 219 | 154 | 262 | 267 | 308 | 133 | 97 | 51 | 19 | 27 | 9 | . | 4 | 3,061 |
| October | 110 | 6 | 4 | ... | 7 | 7 | 29 | 78 | 31 | 149 | 73 | 162 | 13 | 13 | 13 | 207 | 50 | 40 | 107 | 49 | 63 | 142 | 211 | 419 | 406 | 395 | 8 | 119 | 19 | 142 | 93 | 70 | 3,235 |
| November | 785 | 464 | 359 | 616 | 334 | 240 | 43 | 70 | 28 | 7 | .. | 63 | 22 | 86 | 12 | 5 | 3 | 4 | ... | .. | 13 | 26 | 13 | ... | 4 | 28 | ... | 12 | 74 | 480 | 205 | 421 | 4,417 |
| December | 1,216 | 647 | 559 | 630 | 125 | 169 | 82 | 63 | ... | .. | ... | ... | . | .. | ... | ... | .. | ... | ... | ... | . | .. | ... | .. | ... | ... | ... | ... | ... | 161 | 636 | 627 | 4,915 |
| Annual | 2,299 | 1,434 | 1,657 | 3,135 | 2,220 | 1,588 | 1,034 | 1,113 | 1,128 | 1,206 | 1,504 | 3,131 | 3,094 | 4,326 | 3,596 | 2,156 | 933 | 1,707 | 1,280 | 1,595 | 1,014 | 1,093 | 1,486 | 1,983 | 1,570 | 1,252 | 396 | 515 | 314 | 958 | 1,067 | 1,177 | 52,961 |

# APPENDIX X.

MADRAS OBSERVATORY.—Number of inches of rain from each point in the year 1917.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | ... | ... | ... | ... | ... | ... | 0·10 | 0·28 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| February | ... | ... | ... | ... | ... | 0·04 | 0·02 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| March | ... | ... | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | | ... | ... | ... | ... |
| April | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| May | ... | ... | ... | ... | ... | ... | ... | ... | | ... | | 0·03 | ... | ... | 0·03 | 0·37 | 0·01 | ... | | ... | ... | ... | ... | 0·04 | ... | 0·07 | ... | ... | 0·03 | ... | 0·04 | ... | |
| June | ... | ... | ... | ... | 0·03 | 0·23 | ... | ... | 0·06 | 0·07 | ... | ... | 0·40 | ... | ... | 0·08 | 0·60 | 0·12 | | 0·19 | ... | 0·08 | 0·70 | 0·78 | 0·43 | 0·10 | ... | 0·12 | 1·05 | 0·11 | 0·25 | ... | 0·04 |
| July | ... | | ... | ... | ... | ... | 0·32 | ... | ... | ... | ... | ... | 0·01 | ... | | 0·06 | 0·06 | 0·82 | 0·02 | 0·07 | 0·57 | 0·12 | 0·32 | 0·17 | 1·38 | 0·29 | ... | ... | ... | ... | ... | ... | ... |
| August | 0·35 | ... | ... | ... | ... | ... | ... | ... | | 0·04 | 0·20 | ... | | ... | 0·48 | 0·02 | 0·29 | 0·39 | 0·35 | 0·34 | 0·75 | 0·44 | 0·46 | 0·79 | ... | ... | ... | 1·17 | 0·06 | 0·26 | ... | ... | ... |
| September | 0·18 | ... | ... | ... | ... | ... | | 0·05 | ... | ... | ... | 0·19 | 0·48 | 0·37 | 0·03 | 0·02 | 0·02 | 0·54 | ... | ... | 0·09 | 0·05 | 0·32 | ... | 0·31 | 1·93 | 0·14 | 0·09 | 0·27 | ... | ... | ... | 0·22 |
| October | 1·20 | ... | 0·34 | 0·03 | ... | ... | 0·56 | ... | ... | | ... | ... | ... | ... | ... | 0·47 | 0·04 | ... | 0·20 | ... | 0·50 | 0·73 | ... | 2·13 | 0·82 | 0·58 | ... | 1·44 | ... | 6·89 | 0·41 | ... | 0·14 |
| November | 0·32 | 0·02 | 0·40 | 0·19 | 0·56 | ... | 0·35 | ... | 0·12 | ... | ... | ... | 0·02 | 1·31 | ... | ... | ... | ... | ... | ... | 0·13 | ... | ... | ... | ... | 0·11 | ... | ... | 0·12 | 1·10 | 0·03 | 1·24 | 0·01 |
| December | 2·12 | 0·12 | 0·95 | 0·19 | ... | 0·37 | ... | 0·01 | ... | ... | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·76 | 0·91 | 0·63 | ... |
| Annual | 4·17 | 0·14 | 1·69 | 0·41 | 0·59 | 0·64 | 1·35 | 0·34 | 0·18 | 0·11 | 0·20 | 0·22 | 0·91 | 1·68 | 0·54 | 1·02 | 1·02 | 1·87 | 0·57 | 0·60 | 2·04 | 1·42 | 1·80 | 3·91 | 2·94 | 3·17 | 0·14 | 2·82 | 1·53 | 9·12 | 1·64 | 1·87 | 0·41 |

# APPENDIX XI.

MADRAS OBSERVATORY.—Wind, cloud and bright sunshine, 1917.

| Month. | Wind resultant. | | Cloud (0—10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H. | 16 H. | 20 H. | Mean. | Average per day. | Greatest number of hours in a day. |
| | MILES. | POINTS. | | | | | | HOURS. | HOURS. |
| January | 142 | NE by E. | 3·6 | 4·0 | 2·8 | 2·9 | 3·4 | 7·5 | 9·2 |
| February | 95 | East | 2·9 | 3·4 | 2·7 | 2·4 | 2·9 | 8·5 | 11·0 |
| March | 103 | ESE. | 2·9 | 3·5 | 1·5 | 1·8 | 2·4 | 8·1 | 10·2 |
| April | 180 | SSE. | 2·3 | 2·2 | 1·5 | 0·8 | 1·7 | 9·2 | 10·8 |
| May | 129 | SSE | 2·2 | 1·8 | 2·8 | 3·0 | 2·5 | 7·8 | 9·7 |
| June | 95 | S. by W. | 6·1 | 5·6 | 8·2 | 6·7 | 6·7 | 7·3 | 7·5 |
| July | 80 | SW. by S. | 7·1 | 6·6 | 7·1 | 6·4 | 6·8 | 3·9 | 8·6 |
| August | 67 | SW. by S. | 5·7 | 5·5 | 7·8 | 5·1 | 6·1 | 4·0 | 9·1 |
| September | 48 | SSW. | 6·9 | 7·2 | 6·4 | 6·2 | 6·7 | 3·7 | 9·1 |
| October | 42 | W. by S. | 5·0 | 5·1 | 5·6 | 4·4 | 5·1 | 5·6 | 10·4 |
| November | 115 | N. by E. | 6·6 | 6·8 | 6·3 | 5·1 | 6·2 | 4·6 | 9·7 |
| December | 143 | N. by E. | 4·3 | 4·8 | 5·7 | 4·6 | 4·9 | 5·6 | 8·4 |
| Annual | 30 | SE. by E. | 4·6 | 4·7 | 4·9 | 4·1 | 4·6 | 6·3 | ... |

APPENDIX XII.

MEAN Monthly and Annual Meteorological Results at the Madras Observatory in 1917.

| Month. | Barometer. | | Dry Bulb Thermometer. | | | | Wet Bulb. | | Tension of Vapour. | Relative Humidity. | Sun Max. in Vac. | Min. on Grass. | Wind. | | | Rain. | | Cloud. | Bright Sunshine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reduced to 32°. | Daily Range. | Mean. | Max. | Min. | Range. | Mean. | Min. | By Blandford's Tables. | | | | Daily Velocity. | Mean Direction. | | Amount. | Days. | | |
| | Inches. | Inches. | ° | ° | ° | ° | ° | ° | Inches. | Cents. | ° | ° | Miles. | Points | Points. | Inches. | No. | Cents. | Hours. |
| January | 30·012 | 0·111 | 76·2 | 83·8 | 69·1 | 14·7 | 69·3 | 66·1 | 0·623 | 69 | 149·5 | 65·5 | 168 | 5 | NE. by E. | 0 38 | 1 | 34 | 231·6 |
| February | 29·933 | ·123 | 77·4 | 85·8 | 69·5 | 16·3 | 71·2 | 67·5 | ·680 | 72 | 151·6 | 66·7 | 128 | 8 | East. | 0·06 | 2 | 29 | 239·2 |
| March | ·885 | ·125 | 80·5 | 89·3 | 71 8 | 17·5 | 73 8 | 70 2 | ·744 | 71 | 154·5 | 69·2 | 128 | 10 | ESE. | ... | .. | 24 | 252·2 |
| April | ·799 | ·132 | 84·4 | 93·1 | 77·7 | 15·4 | 78·1 | 75·5 | ·874 | 74 | 155·3 | 76·1 | 186 | 13 | SE. by S. | | . | 17 | 277·4 |
| May | ·775 | ·131 | 86·3 | 97·0 | 79·6 | 17·4 | 77·4 | 74·5 | ·816 | 65 | 152·7 | 77·9 | 187 | 14 | SSE. | 0·62 | 4 | 25 | 241·9 |
| June | ·686 | ·113 | 84·4 | 94·5 | 78·5 | 16·0 | 77·6 | 74·8 | ·852 | 72 | 140·1 | 77·5 | 155 | 19 | SW. by S. | 5·53 | 10 | 67 | 110·2 |
| July | ·688 | ·120 | 84 9 | 95·1 | 78·7 | 16·4 | 77·6 | 74·3 | ·816 | 71 | 144·4 | 77·4 | 148 | 19 | SW. by S. | 4·21 | 15 | 68 | 120·9 |
| August | ·722 | ·122 | 83·1 | 92·1 | 77·1 | 15·0 | 78·0 | 75·1 | ·889 | 79 | 145·0 | 76·3 | 128 | 19 | SW. by S. | 6·39 | 18 | 61 | 122·5 |
| September | ·738 | ·128 | 81·9 | 90·0 | 76·6 | 13·4 | 77·5 | 74·7 | ·885 | 82 | 148·3 | 75·2 | 102 | 17 | S. by W. | 5·30 | 16 | 67 | 111·2 |
| October | ·776 | ·129 | 81·1 | 89·0 | 75·3 | 13·7 | 76·1 | 72·9 | ·831 | 79 | 148·7 | 73·8 | 104 | 22 | W. S. W. | 16·48 | 11 | 51 | 174·3 |
| November | ·877 | ·106 | 79·0 | 85·0 | 74·3 | 10·7 | 75·0 | 72·6 | ·814 | 82 | 142·3 | 72·6 | 147 | 2 | N. N. E | 6·03 | 17 | 62 | 137·3 |
| December | ·912 | ·107 | 75·1 | 82·6 | 69·0 | 13·6 | 70 4 | 67·7 | ·682 | 78 | 145·3 | 70 4 | 159 | 1 | N. by E. | 6·06 | 7 | 49 | 172·2 |
| Annual | 29 817 | ·121 | 81·2 | 89·8 | 74·8 | 15·0 | 75·2 | 72·2 | ·792 | 75 | 148·1 | 73·2 | 145 | 12 | SE. | 51·06 | 101 | 46 | 2190·9 |

EXTREME Monthly Meteorological Records at the Madras Observatory in 1917.

| Month. | Barometer. | | | | | Dry Bulb Thermometer. | | | | Wet Bulb. | | Humidity. | | Sun Th. in Vacuo. | | Grass Therm. | | Wind. | | | | Rain. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | | Lowest. | | Range. | Highest. | | Lowest. | | Lowest. | | Lowest. | | Highest. | | Lowest. | | Highest. | | Lowest. | | Greatest Fall. | |
| | Inches. | Day. | Inches. | Day | Inches. | ° | Day. | ° | Day. | ° | Day. | Cents | Day. | ° | Day. | ° | Day. | Miles. | Day. | Miles. | Day. | Inches. | Day. |
| January | **30·150** | **9** | 29·898 | 28 | 0·252 | 85·4 | 15 | 63·1 | 25 | 62 0 | 25 | 48 | 29 | 156·5 | 28 | 59·3 | 25 | **299** | **9** | 64 | 25 | 0·38 | 31 |
| February | ·113 | 8 | ·718 | 26 | **·395** | 90·4 | 26 | **60·7** | **19** | **60 2** | **19** | 42 | 19.20 | **164·1** | **28** | **57·3** | **19** | 260 | 7 | 68 | 12 | 0·05 | 8 |
| March | ·068 | 29 | ·752 | 5.6 | ·316 | 91·4 | 18 | 64·5 | 3 | 63·2 | 3 | 39 | 16 | 158·5 | 11 | 61·1 | 3 | 197 | 1 | 78 | 13 | .. | ... |
| April | 29·943 | 5 | ·654 | 16 | ·289 | 101 5 | 16 | 73·1 | 29 | 71·9 | 28.30 | 41 | 17 | 161·4 | 16 | 71·5 | 27 | 268 | 14 | 83 | 26 | | .. |
| May | ·946 | 19 | ·591 | 31 | ·355 | **105.3** | **25** | 74·3 | 29 | 68·8 | 4 | 36 | 26 | 158·6 | 24 | 72·0 | 29 | 250 | 8 | 118 | 31 | 0·38 | 11 |
| June | ·813 | 16 | **·542** | **13** | ·271 | 100·3 | 21 | 75·2 | 14 | 72·4 | 28 | **31** | **20** | 159·3 | 13 | 69·8 | 6 | 208 | 12 | 85 | 7 | 1·59 | 3 |
| July | ·878 | 5 | **·542** | **19** | ·336 | 101 0 | 8 | 73·7 | 5 | 72·7 | 5 | 37 | 9 | 155·2 | 14 | 73·2 | 5 | 212 | 22 | 110 | 19 | 0·89 | 26 |
| August | ·878 | 29 | ·555 | 7 | ·323 | 98·3 | 2 | 73·7 | 29 | 73·0 | 29 | 46 | 9 | 161·5 | 20 | 73·1 | 29 | 200 | 7 | 81 | 14 | 1·74 | 21 |
| September | ·864 | 22 | ·579 | 8 | ·285 | 94·0 | 4 | 72·5 | 3.30 | 73·0 | 15 | 51 | 8 | 161·3 | 19 | 73·0 | 30 | 159 | 4 | 64 | 24 | 2·07 | 30 |
| October | ·956 | 14 | ·619 | 4 | ·337 | 94·5 | 9 | 72 0 | 2 | 68·0 | 6 | 50 | 30 | 162·4 | 23 | 68·0 | 30 | 184 | 4 | 56 | 23 | **6·52** | **20** |
| November | 30·061 | 30 | ·676 | 12 | ·385 | 89·5 | 4 | 70·2 | 30 | 69·2 | 23 | 59 | 1.3 | 159·5 | 28 | 66·6 | 30 | 253 | 11 | **54** | **17** | 1·31 | 11 |
| December | ·058 | 19 | ·760 | 8 | ·358 | 86·9 | 31 | 63·7 | 30 | 61·6 | 30 | 51 | 30 | 156·9 | 27 | 59·4 | 30 | 218 | 7 | 85 | 16 | 2·62 | 5 |

# ANNUAL REPORT

OF THE

# DIRECTOR

# KODAIKANAL AND MADRAS OBSERVATORIES

## FOR 1918

MADRAS:
PRINTED BY THE SUPERINTENDENT, GOVERNMENT PRESS.

1919.

# KODAIKANAL AND MADRAS OBSERVATORIES.

## REPORT FOR THE YEAR 1918.

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### II.—MADRAS OBSERVATORY.

# KODAIKANAL AND MADRAS OBSERVATORIES.

## I.—REPORT OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1918.

*Staff.*—The staff of the Observatory on December 31, 1918, was as follows:—

| | |
|---|---|
| Director ... ... ... ... | J. Evershed, F.R.S. |
| Assistant Director ... ... ... | T. Royds, D.Sc. (on deputation).<br>S. Sitarama Ayyar, acting sub. *pro tem.* |
| First Assistant ... ... ... | S. Sitarama Ayyar, B.A.<br>A. A. Narayana Ayyar, acting sub. *pro tem.* |
| Second Assistant ... ... ... | A. A. Narayana Ayyar, B.A. |
| Third Assistant ... ... ... | S. Balasundaram Ayyar. |
| Fourth Assistant ... ... ... | Vacant. |
| Writer ... ... ... ... ... | L. N. Krishnaswami Ayyar. |
| Photographic Assistant ... ... | R. Krishna Ayyar. |

MAGNETIC SECTION.

| | |
|---|---|
| Magnetic Observer ... ... ... | S. S. Ramaswami Ayyangar, B.A. |
| Magnetic Recorder ... ... ... | S. S. Ranga Acharya. |

The death occurred on October 14 of Second Assistant G. Nagaraja Ayyar after a partial recovery from a severe attack of influenza. He joined the staff of the Observatory in April 1, 1899, as writer and was promoted to Second Assistant on February 12, 1909. Mr. Nagaraja Ayyar was a good observer and was very skilful in the handling of instruments. He early succeeded in photographing an excellent series of spectra of large sunspots and was the author of a paper on the weakened lines in spot spectra published in the Astrophysical Journal in 1907, Vol. XXVI, p. 143.

The subordinate staff consists of a book-binder, an assistant book-binder, a mechanic, six peons, a boy peon for the dark room and two lascars.

2. *Instruments.*—With the exception of the new constructions and adaptations mentioned in paragraph 16 the instrumental equipment of the Observatory has remained the same. The 15-inch lens borrowed from the Nizamiah Observatory, Hyderabad, is still in use for photographing solar and Venus spectra. The Kullberg sidereal chronometer lent to the Nizamiah Observatory in 1917 remains at that Observatory.

3. *Weather conditions.*—The partial failure of the south-west monsoon in the months June to September inclusive resulted in less unfavourable conditions than is usual in those months. On the other hand the months of May and November were unusually cloudy and wet. The mean definition in the north dome between 8 and 10 a.m. was 2·9 on a scale in which 1 is the worst and 5 the best; the best monthly mean was 3·3 in April and in December. There were thirty-nine days in the year when the definition was 4 or over.

### *Photographic and visual observations.*

4. *Photoheliograph.*—Photographs on a scale of 8 inches to the Sun's diameter were obtained on 303 days. In June the 6-inch photo-visual lens previously employed for this work was replaced by a visual

achromatic of the same diameter and focal length, and the daily photographs are now taken with a green colour screen limiting the effective light to the spectral region between F and G. Some experimental photographs have also been obtained in red light with lantern plates dyed with pinacyanol.

5. *Spectroheliographs.*—Monochromatic images of the disc in K light were obtained on 337 days, prominence plates on 249 days and H$\alpha$ disc plates on 261 days.

6. *Six-inch Cooke equatorial and spectroscope.*—Work with this instrument has been continued on the same lines as formerly for visual observations of solar phenomena which cannot be readily photographed.

7. *Grating spectrograph.*—This was employed mainly in researches connected with displacements of the solar lines, the programme of work including photographs of the spectrum of Venus with Fe arc comparison lines, also control plates of sunlight and Fe arc. A good series of third and fourth order plates of the carbon arc and solar spectra was secured for measuring the displacements of the cyanogen band-lines near $\lambda$ 3883. During a spell of exceptionally clear sky in February and March about fifty solar rotation plates were also obtained.

8. *The Venus spectra.*—In the six months April to September inclusive high-dispersion Venus spectra were obtained on twenty-seven mornings. These and 31 plates of sunlight spectra have all been measured by the positive on negative method, and yield results of great interest. The control plates taken under precisely the same conditions as the Venus plates give a mean shift of the more affected iron lines in the region 4337—4494 of + 0·010A, and of the less affected lines + 0·003A. The Venus plates taken near the western elongation of the planet, when the angle Venus-Sun-Earth was about 45°, yield slightly smaller values of the shifts, and there is a progressive diminution of wave-length as the angle at the Sun increases. When this angle exceeds 90° the displacements Sun — arc all have the minus sign, that is the solar lines reflected by Venus are shifted to violet instead of to red with reference to the iron arc.

This very striking result is shown in the following table:—

| Month. | Mean angle. ♀—☉—⊕ | Displacements in angstroms. More affected lines. | Displacements in angstroms. Less affected lines. |
|---|---|---|---|
| April and May .. . .. | 45° | + 0·008 | + 0·002 |
| June ... ... ... ... | 75° | + 0·002 | − 0·002 |
| July ... . . ... ... | 95° | − 0·001 | − 0·004 |
| September ... ... ... | 135° | − 0·006 | − 0·010 |

It also appears that the more affected lines diminish in wave-length more than the less affected lines, so that when the light is derived from a hemisphere of the Sun turned about 90° to Earth, the Fe arc and solar lines nearly coincide.

The result of the Venus work seems to dispose finally of the possibility that the solar line-shifts are due to the gravitational effect resulting from Einstein's generalized relativity hypothesis. As the shift towards red of the solar lines, according to these observations, is only observed in the light derived from a hemisphere of the Sun facing towards Earth, it seems necessary to admit an earth effect whether the shift is interpreted as motion or otherwise. It is very desirable that confirmation of these results should be obtained independently by other observers.

The Venus spectra obtained in 1918 leave still undecided the question of the rotation period of the planet, although such evidence as has been obtained favours a short period. Four excellent plates obtained in November and December 1917 near the eastern elongation of the planet

give consistently low values of the orbital velocity, but this may be interpreted in two ways: either the planet rotates in the same direction as the Earth and with approximately the same period, or the Sun—arc displacements are not constant but liable to considerable changes.

It was hoped to obtain confirmation of the low values of orbital velocity, implying a rapid and direct rotation, at the western elongation of the planet in April; but owing to the very bad definition prevalent in the spring months at Kodaikanal, it was found impossible in a long exposure to keep the planet in a fixed position on the spectrograph slit. The spectra therefore represent more or less the integrated light of the half disc, including rays from parts of the planet approaching the Earth, and from other parts receding from the Sun; resulting in a partial compensation of the effect looked for. The mean of eight plates gives an orbital velocity only 0·7 per cent below that derived from Nautical Almanac data, whilst the plates taken at eastern elongation gave a value 3·5 per cent below the calculated velocity, a defect which is over ten times the probable error of a single plate.

The uncertainty as to the effect of the planet's rotation, and the possibility of variations in the wave-lengths of the solar lines, make it useless at present to derive a value of the solar parallax from the determinations of orbital velocity. Observations have been instituted however to test the constancy of the Sun—arc shift. Plates taken at weekly intervals in September, October and November indicate only very small changes when longitudes on the Sun differing by 90° are compared; but monthly tests will also be made, extending over a much longer period.

In photographing the spectrum of Venus with the grating spectrograph in the blue and violet regions, it was noticed that longer exposures were required than is necessary when the image of a brightly illuminated terrestrial cloud is brought on to the slit. Direct comparisons of the spectra in a low dispersion prism spectrograph, using a parabolic mirror to form the image of Venus, showed that with exposures regulated to give equal density in the green region the Venus spectra are much weaker in the violet than the cloud spectra, suggesting that the atmosphere of Venus is devoid of clouds, or if these are present the atmosphere above them must be strongly absorptive for the violet rays.

9. *The cyanogen bands.*—The measures of the cyanogen band-lines in the Sun and in the carbon arc have shown that most of the lines are shifted towards red, both at the centre of the disc and at the limb, and as in the case of iron the stronger lines give the larger shifts. The shift at the limb is on the average greater than at the centre of the disc, but is less than the theoretical gravitational shift equivalent to 0·634 km./sec. A systematic difference was found between north and south polar limbs, which requires further investigation.

10. *The solar rotation.*—Of the series of plates of the H$\alpha$ region obtained in the fine weather of March and April, 32 have been measured by the positive on negative method. The results show that despite the increased accuracy obtained in the measures large discordances in rotational velocity are still found in individual plates. In the equatorial regions, where spot disturbances are generally absent, plates taken on the same day will sometimes differ by as much as 3 per cent. The provisional mean value of the sidereal velocity at the equator from this series of plates is about 1·92 km./sec. but the extreme values differ by about 6 per cent in excess or defect of this. The average probable error of a plate from ten strong Ca and Fe lines of mean intensity 6 is $\pm$0·006 km./sec. In exceptionally good plates it is as low as $\pm$ 0·003 km./sec. The measuring errors are found to be smaller than the plate irregularities. Probably more uniform results might be obtained if the solar image were not well focussed on the slit, or were affected by astigmatism, so that the light forming the spectrum would be derived from a larger area of the Sun's

surface. The question of haze affecting the results is ruled out by the fact that photographs were obtained only on the clearest possible days.

In the case of the H$\alpha$ line, which was also measured, the local distortions are nearly always present, and greatly interfere with the accuracy of the measures. The velocities obtained are generally but not always larger than for the iron lines. The mean equatorial velocity derived from H$\alpha$ is 2·05 km./sec.

11. *Nova aquilæ.*—Two series of prismatic camera spectra of the Nova were obtained between June 12 and July 11, and the result of a study of these have been communicated to the Royal Astronomical Society. The changing wave-lengths of the double series of hydrogen absorption lines and of the enhanced lines of iron suggest an analogy with the solar eruptive prominences, for Kodaikanal photographs have proved these to move out from the Sun with accelerating velocity, indicating the action of a repulsive force, which is probably operative also in novæ. The hydrogen emission bands in the Nova are shown to have widths proportional to wave-length, which would not be the case if pressure or density were concerned in the widening ; it is therefore considered to be a Doppler effect also, due to a vast explosion or expansion of the gases in all directions. The narrow absorption line H which is found superposed upon the broad emission band H$\epsilon$ is shown to have a displacement which is almost the same in amount and sign as that due to the solar motion in space, implying a stationary condition of the calcium vapour with reference to the sidereal system ; it probably has no connexion with the star, and appears to be widely distributed in the milky way region.

12. *Conjunction of Venus and Sun.*—Arrangements were made with the 6-inch photoheliograph to obtain a series of photographs of Venus in red light, before, during, and after superior conjunction with the Sun, by the method proposed by Mr. Lindemann for photographing Regulus in conjunction with the Sun. On November 24 the planet was within 6′ of the Sun's limb and had it been possible to carry out the programme it would have been of great interest to ascertain whether the track of the planet was bent inwards towards the Sun (Einstein effect) or pursued a perfectly straight path past conjunction. On October 28 the sky was perfectly clear and it was found possible to photograph the planet, then only 7° west of the Sun, with a red filter and special arrangements for blocking out scattered sunlight. An exposure of 10 seconds was found sufficient to give a distinct image of the planet with plates dyed with pinacyanol. The scale is nearly 10″ to the millimeter, equivalent to a ratio $F/A=140$, enlarging lenses being used and a mirror to reflect the image to a convenient position. The red glass filter was placed near the focus of the 6-inch object glass ; and in order to obtain photographs on the day of conjunction the filter was carefully silvered, the Sun's image could then be brought on to it without risk of fracturing the glass. At the same time, owing to the partial transparency of the silver film, sufficient red light was transmitted to give a distinct photograph of the Sun with a 10 seconds exposure. A small part of the film was removed to allow the light of Venus to be freely transmitted. It was hoped by this means to photograph both planet and Sun with a single exposure, but everything would depend on the purity of the sky near the Sun and the absence of scattered light in the instrument.

Experiments showed that there was considerable fogging of the plate through the opening in the silver film when the Sun was photographed in this way, but perhaps not enough to entirely block out the image of Venus. However after October 28 no clear skies occurred for about two months and the experiments were abandoned.

A more hopeful method would be to abolish the enlarging lenses and mirror and use a single object lens of at least 20 feet focus attached to a large equatorial. With a filter transmitting the extreme red and infra

red, and plates sensitised with dicyanin Venus could probably be photographed in superior conjunction with the Sun ; but a non-diffusive sky and good definition would be essential conditions, and these could probably be found only on an oceanic island, or in Kashmir.

*Summary of sunspot and prominence observations.*

13. *Sunspots.*– The following table shows the monthly numbers of new groups observed at Kodaikanal, and their distribution between the northern and southern hemispheres. The mean daily numbers of spots visible are also given :—

| — | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups .. ... | 30 | 19 | 28 | 26 | 31 | 25 | 35 | 32 | 24 | 32 | 27 | 23 | 332 |
| North ... .. | 15 | 11 | 11 | 11 | 17 | 16 | 18 | 15 | 11 | 18 | 14 | 8 | 165 |
| South ... | 15 | 8 | 17 | 15 | 14 | 9 | 16 | 16 | 13 | 14 | 12 | 15 | 164 |
| Equator . ... | ... | . | . | ... | | . | 1 | 1 | ... | ... | 1 | | 3 |
| Daily numbers ... | 6·8 | 4·4 | 5·0 | 5·7 | 5·1 | 3·9 | 6·7 | 5·2 | 4·1 | 5·8 | 5·1 | 4·2 | 5·2 |

The maximum spot activity of the present cycle took place during the second half of 1917 for both hemispheres when the mean monthly number of new groups reached 17 for the northern hemisphere, and 16 for the southern ; and the mean daily number rose to 7·1. The above table for 1918 shows a considerable reduction in these figures.

The number of new groups decreased more rapidly in the northern hemisphere than in the southern and in 1918 the spot activity was about equal in the two hemispheres.

The approximate mean latitude of the spots was 11°·8 in the northern hemisphere and 14°·6 in the southern, a decrease of over 2° in each hemisphere compared with 1917.

The number of bright reversals and of displacements of the H$\alpha$ line fell from 483 and 133 respectively in 1917, to 422 and 108 in 1918. There were 44 observations of $D_3$ as a dark line in 1918, the great majority being recorded during the first half of the year.

14. *Prominences.* A rapid decline in prominence activity occurred during 1918. The mean daily areas in square minutes of arc, derived from the Kodaikanal photographic records, are as follows :—

| | North. | South. | Total. |
|---|---|---|---|
| 1918 January to June .. ... | 2·28 | 2·72 | 5·00 |
| July to December .. | 1·24 | 1·99 | 3·23 |

The mean daily number recorded also fell from 18·2 for the first six months to 16·1 for the second half of the year.

The high latitude prominences reached their greatest development, in the southern hemisphere, and the closest approach to the poles during the early months of the year and then rapidly declined. After July there were no prominences of any magnitude recorded between latitude + 50 and the north pole. In the south the polar regions maintained some activity until the end of the year. This decline of the polar prominences is a well marked phase in the prominence cycle and occurred last in the year 1907.

Prominences generally attained a maximum development in the northern hemisphere early in 1917, whilst the southern maximum occurred during the first half of 1918. This delayed action of the south

has caused a reversal of the relative activity of north and south as is seen on comparing the areas given above with those in the report for 1917.

Prominences projected on the disc as absorption markings attained their greatest development during the first six months of 1918 in both hemispheres, but there was a rapid decline during the latter half of the year in the northern hemisphere only.

Prominence areas east and west of the Sun's axis show a western excess during the first half of the year and an eastern excess during the second half. The denser prominences showing as absorption markings give the usual eastern excess throughout the year, the areas recorded east of the meridian being 52·4 per cent of the whole, derived from 5720 markings. Metallic prominences and prominences showing displaced lines were more frequent on the western limb than on the eastern.

The usual excess of displacements towards red is indicated for the hydrogen lines both at the limb and on the disc.

15. *Magnetic observations.*—Continuous magnetograph records are obtained of declination, vertical force, and horizontal force. Absolute observations for dip are made daily excepting Sundays, declination and horizontal force on three days per week alternately. All the records are made over to the Magnetic Survey Office, Dehra Dun, and the results are published by the Survey annually.

The vertical force magnetograph had occasionally to be readjusted during the year, and the earth inductor gave trouble owing to wear of the commutator, which was turned true in December.

Twenty-three "great" and 136 "moderate" magnetic storms were registered during the year. March, November, and December, were the most active months of the year, and January was the quietest month. There were nine "great" storms recorded in December.

16. *Workshop construction.*—The heavy equatorial mounting of the Poona 20-inch reflector was erected under the old sliding roof originally used for covering the siderostat of the spectroheliograph. This roof was mounted on rails and made more manageable by cutting off one-third of its length. The driving clock of the equatorial was repaired and put into working order.

A truck built of teakwood with flanged brass wheels was constructed and mounted on rails in the spectroheliograph building, about twelve feet from the siderostat mirror. On the truck an 18-inch parabolic mirror is mounted, and this can now be used alternatively with the spectroheliographs and other instruments depending on the 18-inch siderostat. A prism spectrograph was also arranged near the siderostat for use with the parabolic mirror for star or comet spectra.

A Hilger micrometer of old pattern but provided with a high quality screw was entirely reconstructed and converted into a positive on negative micrometer. The screw is mounted near the base plate of the machine and is connected with a carriage provided with accurately turned wheels running on straight gun-metal ways. The microscope is of novel design consisting of two opposed object lenses each of 9½ inches focal length, and an eye-piece. The distance of about 20 inches separating the conjugate foci of the lenses is shortened by an arrangement analogous to that used in prism binoculars. The long focus solves the difficulty experienced with ordinary microscopes of focussing simultaneously the positive and negative films, which are necessarily separated by a small space.

17. *Time.*—The error of the standard clock is usually determined by reference to the 16-hour signal from the Madras Observatory. This is rendered possible by the courtesy of the Telegraph Department which permits the Madras wire to be joined through to this observatory. The signal is received with accuracy on most days and all failures are at once reported to the Postmaster-General, Madras.

18. *Meteorology.*—Eye observations are made at $8^h$, $10^h$ and $16^h$ local mean time as in former years. The Richard thermograph (wet and dry bulb) and barograph, the Beckley anemograph, and the sunshine recorder also continue in use. Cloud observations with the nephoscope are made three times daily.

*Pressure.*—The mean annual pressure differed very little from the normal but there were large variations in the individual months. The pressure was in excess in the monsoon months June to October inclusive and largely in defect in January and May.

*Temperature.*—The mean annual temperature was slightly higher than the normal, the greatest excess was 3° in July. The grass minimum temperature for the whole year was 23°·0 recorded on the 3rd February.

*Humidity.*—The monsoon months June to October inclusive were drier than normal but the mean humidity for the year was only 1 cent below normal.

*Rainfall.*—The total annual rainfall was in defect by 2·18 inches only, but there was a defect of 11·26 inches in the months July to October inclusive. There was an excess of 2·86 inches in January and 7·95 inches in November.

*Wind.*—The mean daily wind movement was 276 miles, the normal being 306 miles. The defect occurred mainly in the months June to October. The greatest excess was in May. The mean direction in that month was S. by W., the normal direction being N.N.E.

*Transparency of the atmosphere.*—The transparency of the lower atmosphere as judged by the visibility of the Nilgiris, about 100 miles distant, was much below the average.

*Cloud and sunshine.*—The mean amount of cloud was in excess in January, May, November and December. The total number of hours of bright sunshine was 2399 which is 18 per cent above normal.

The most striking features in the weather at Kodaikanal in 1918 were (1) the early arrival of the south-west monsoon, which set in three weeks before the normal date, (2) the partial failure of the monsoon in the months July to October inclusive and (3) the heavy rains in January and November.

19. *Seismology.* The Milne horizontal pendulum recorded one hundred and twenty-seven earthquakes, an exceptionally large number. Details of the records are given in Appendix I.

20. *Library.*—One hundred and seven volumes were bound during the year.

21. *Publications.*—Bulletin Nos. 58 and 59, dealing with the prominences of the second half of 1917 and the first half of 1918, were issued during the year; but only a few copies were distributed privately outside India.

KODAIKANAL,
*6th February* 1919.

J. EVERSHED,
*Director, Kodaikanal and Madras Observatories.*

## II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1918.

*Staff.*—The staff of the Observatory on 31st December 1918 was as follows :—

| | |
|---|---|
| Deputy Director ... ... ... ... | R. Ll. Jones. |
| Computer ... ... ... ... ... | S. Solomon Pillai. |
| First Assistant ... ... ... ... | C. Chengalvaraya Mudaliyar. |
| Second Assistant ... ... ... ... | P. Jayaram. |

I was on leave from the 1st May to 16th June 1918 and Mr. James Angus was in charge of the Observatory and the Meteorological office during my absence. Mr. Solomon Pillai was absent on privilege leave from 15th July to 3rd September. Mr. E. Ramanujam Pillai, the Second Assistant, was transferred to the Meteorological office on 16th March 1918.

2. *Time service.*—The time gun at Fort St. George failed on 27 occasions out of 730 giving a percentage of success of 96. Of these failures 3 were due to faults at the Observatory. The time ball at the Harbour failed altogether on eight days. On four of these days the releasing apparatus at the Harbour was out of order and on two other days the lines were interrupted. None of these failures were due to faults at the Observatory. On twelve other days the time ball failed at 1 p.m. but dropped correctly at 2 p.m. Most of these partial failures were found to be due to the fact that the line was interrupted at the Central Telegraph office at 1 p.m. by some one who did not know that it was required at that hour for another purpose. The 4 p.m. roll of signals was sent to the Central Telegraph office on every day and was received there correctly except on five occasions when the diffuser had not been joined on.

3. *Meteorological observations.*—Eye observations were made at $8^h$, $10^h$, $16^h$, and $20^h$, local mean time as in former years. The Richard thermograph and barograph, the Beckley anemograph, the sunshine recorder and self-registering rain-gauge also continue in use. Extra observations were taken for storm warning purposes and telegrams sent to Calcutta on 47 occasions and to Simla on one occasion.

4. *Buildings.*—The usual annual repairs to the office and quarters were carried out during the year.

5. *Instruments.*—The following is a list of the instruments at the Observatory on 31st December 1918 :—

(*a*) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton and Simms.
Sidereal clock—Haswall.
  Do. Dent, No. 1408.
  Do. S. Riefler, No. 61.
Mean Time clock—J. H. Agar Baugh, No. 105.
  Do. with galvanometer—Shepherd & Sons.
Meridian circle—Troughton and Simms.
Portable transit instrument—Dolland.
Portable telescope with stand.
Tape chronograph—R. Fuess.
Relay for use with the chronograph—Siemens.

(*b*) *Meteorological.*

Richard's barograph—No. 10, L. Casella.
  Do. thermograph—No. 29637, L. Casella.
Peander's self-recording rain-gauge—No. 116, Lawrence and Mayo.
Beckley's anemograph—Adie.
Sunshine recorder—No. 149, L. Casella.
Nephoscope—Mons Jules Daboseq and Ph. Pellin.

Barometer, Fortins—No. 1771, L. Casella.
Do. do. No. 725, L. Casella (spare).
Do. do No. 1420, L. Casella (spare).
Dry bulb thermometer—No. 94221, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Wet do. No. 94219, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Dry maximum thermometer—No. 8581, Negretti and Zambra.
Dry minimum do. No. 69017, L. Casella.
Wet do. do. No. 91753, Negretti and Zambra.
Sun maximum thermometer—No. 127618, Negretti and Zambra.
Grass minimum thermometer—No. 3377, Negretti and Zambra.
Rain-gauge (8″ diameter)—No. 1042, Negretti and Zambra.
Measure glass for above.
Rain-gauge (5″ diameter).
Measure glass for above.
Stop watch—No. A-3.

The level error of the Transit Circle at the beginning of the year was + 0s·19. Very little change occurred during the first three months. In April it began to change in the usual manner and reached its maximum negative value at the end of October, when the monsoon burst. In the course of a few days of heavy rain at the beginning of November it went through a rapid change in the reverse direction. The error had almost disappeared by the 21st November and at the beginning of this year its value was + 0s·25. It is satisfactory to see that the variations though much larger than is desirable are no longer cumulative.

The rate of the Riefler clock has been very steady during the year. There was however a sudden change on the 9th July which is believed to have been due to the effect of the Calcutta earthquake of 8th July. A report on this matter was sent to Dr. Murray Stuart, who was deputed to investigate the earthquake, on the 11th September.

6. *Weather summary.*—The following is a summary of the meteorological conditions at Madras during 1918 :—

*Pressure.*—The mean monthly pressure was above normal in February, March, June, July, September, October and December and below normal in the remaining months, the greatest excess being 0·049 inch in October and the greatest defect 0·052 inch in January. The highest pressure was 30·119 inches on February 10 and the lowest 29·827 inches on May 1.

*Temperature.*—The mean temperature of the air was above normal in January, July, August, September, October, November and December and below normal in the remaining months. The maximum shade temperature was above normal in April, July, August, September and October and below normal during the rest of the year. The highest temperature recorded was 104°·1 F. on August 4. The minimum in shade was above normal in January, July, August, September, November and December and below normal in the remaining months. The lowest temperature recorded was 60°·8 F. on February 15. The highest sun maximum was 166°·9 F. on September 8 and the lowest on grass was 56°·6 F. on February 15.

*Humidity.*—The percentage of humidity was above normal throughout the year except in July, August and October. The driest day in the year was February 15, when the humidity was only 35.

*Wind.*—The wind velocity was in defect throughout the year except in January. The wind direction was normal in February, March, August and September.

*Cloud.*—The amount of cloud was normal in September and December. In January, May, August and November the sky was more cloudy than usual and less cloudy during the other months.

*Sunshine.*—The percentage of bright sunshine was normal in March, above normal in April, June, July, August and October and below in all

other months. The total number of hours of bright sunshine during the year was 2331·6 against 2190·9 in the previous year.

*Rainfall.*—Rainfall was above the average in January, February, May, November and December and below in the remaining months, the greatest excess being 25·97 inches in November and the greatest defect 6·66 inches in October. The total rainfall for the year was 75·00 inches on 88 days. The monsoon rainfall from October 15 to the end of the year was 50·19 inches. The heaviest rainfall on one day was 6·33 inches on November 2.

*Storm.*—A depression formed in the south of the Bay on the 10th November. It developed into a severe storm and moved in a westerly direction and passed inland a little to the north of Madras shortly after 1 a.m. on the 11th. Between midnight and 1 a.m. the barometer fell about $\frac{1}{4}$ inch and the wind movement at the Observatory for that hour was 39 miles, though velocity in the fierce gusts just before 1 a.m. was much greater than 40 miles per hour. There was a lull between 1–5 a.m. and 1–25 a.m. when winds were very light. At 1–25 a.m. the gusts were renewed, accompanied by a change in wind direction from about N.N.W. to W.N.W. from 3 a.m. and the winds began moderating.

THE OBSERVATORY, MADRAS,
*3rd February* 1919.

R. LL. JONES,
*Deputy Director, Madras Observatory.*

# APPENDIX I.

## STATION—KODAIKANAL OBSERVATORY.

### SEISMIC RECORDS.

$\phi = 10° 13' 50''$ $\lambda = 77° 28' 00''$ $h = 2343$ metres. *Subsoil*—Rock.
*Apparatus*—Milne's Horizontal Pendulum Seismograph.

| 1918. | $T_0$ | $\frac{\tau}{T_0^2}$ | 1918. | $T_0$ | $\frac{\tau}{T_0^2}$ |
|---|---|---|---|---|---|
| January ... ... ... | 17·3 | 2·5 | July ... . ... | 17·6 | 2·6 |
| February ... ... ... | 17·4 | 2·4 | August .. ... .. | 17·7 | 2·6 |
| March ... ... ... | 17·3 | 2·6 | September ... ... | 17·7 | 2·6 |
| April ... ... ... | 17·4 | 2·5 | October ... ... .. | 17·9 | 2·8 |
| May ... ... .. | 17·5 | 2·5 | November ... ... ... | 18·1 | 2·6 |
| June ... ... .. | 17·4 | 2·7 | December ... ... ... | 17·8 | 2·8 |

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period. (Sec.). | AMPLITUDE ($\mu$). AN. | AE. | AZ. | Distance $\triangle$ (Km.). | REMARKS. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1918. | | | | | | | | | | |
| 1 | January 30 ... | eP | 21 | 00 | 18 | ... | . | ... | ... | ... | |
| | | iL | 21 | 35 | 54 | .. | ... | .. | ... | ... | |
| | | M | 21 | 37 | 24 | ... | ... | 180 | ... | ... | |
| | | F | 22 | 34 | 06 | . | ... | ... | ... | ... | |
| 2 | February 4 ... | eP | 18 | 11 | 30 | ... | .. | ... | .. | ... | |
| | | L | | ... | | ... | ... | ... | ... | ... | |
| | | M | 18 | 14 | 06 | ... | ... | 90 | ... | . | |
| | | F | 18 | 31 | 18 | ... | | ... | .. | ... | |
| 3 | 7 ... | eP | 5 | 32 | 06 | ... | ... | ... | ... | ... | |
| | | iL | 5 | 48 | 18 | .. | ... | .. | .. | ... | |
| | | M | 5 | 54 | 42 | .. | ... | 200 | ... | | |
| | | F | 6 | 34 | 36 | ... | ... | ... | ... | ... | |
| 4 | 13 ... | eP | 2 | 13 | 36 | .. | ... | ... | . | ... | |
| | | iL | 2 | 48 | 30 | ... | | | ... | ... | |
| | | M | 2 | 49 | 36 | ... | ... | 220 | ... | ... | |
| | | F | 3 | 32 | 18 | ... | ... | .. | ... | ... | |
| 5 | 13 ... | eP | 6 | 14 | 36 | ... | .. | | ... | ... | |
| | | iL | 6 | 33 | 06 | ... | ... | .. | ... | ... | |
| | | M | 6 | 37 | 12 | ... | ... | 210 | ... | ... | |
| | | F | 8 | 09 | 30 | ... | ... | ... | ... | ... | |
| 6 | 13 ... | eP | 20 | 50 | 12 | . | ... | ... | ... | ... | Widening of line. |
| | | F | 21 | 00 | 36 | ... | ... | .. | ... | . | |
| 7 | 19 ... | eP | 16 | 45 | 24 | .. | ... | ... | ... | .. | Widening of line. |
| | | F | 17 | 46 | 54 | ... | .. | ... | ... | ... | |
| 8 | March 7 ... | P | | ... | | | ... | ... | .. | ... | |
| | | eL | 9 | 10 | 12 | ... | ... | .. | ... | ... | |
| | | M | 9 | 10 | 42 | ... | ... | 60 | ... | ... | |
| | | F | 9 | 16 | 36 | ... | ... | ... | . | ... | |
| 9 | 16 ... | eP | 14 | 55 | 48 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 15 | 08 | 06 | ... | ... | ... | ... | ... | |
| 10 | 17 ... | eP | 14 | 22 | 06 | ... | ... | .. | .. | ... | Widening of line. |
| | | F | 14 | 25 | 12 | ... | ... | ... | ... | ... | |
| 11 | 19 ... | eP | 6 | 54 | 42 | ... | ... | ... | ... | .. | Widening of line. |
| | | F | 7 | 06 | 36 | ... | ... | ... | . | ... | |
| 12 | 20 .. | eP | 0 | 56 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 1 | 01 | 30 | ... | ... | ... | ... | .. | |
| 13 | 24 ... | eP | 23 | 31 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 23 | 40 | 12 | .. | ... | . | ... | ... | |
| 14 | 27 ... | eP | 4 | 20 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 4 | 33 | 18 | ... | ... | ... | ... | ... | |
| 15 | April 10 ... | eP | 2 | 20 | 18 | ... | | ... | ... | ... | |
| | | eL | 2 | 23 | 30 | ... | ... | ... | ... | .. | |
| | | M | 2 | 23 | 48 | .. | ... | 50 | ... | ... | |
| | | F | 2 | 51 | 00 | ... | ... | ... | ... | | |
| 16 | 13 ... | P | | . | | ... | ... | ... | ... | ... | |
| | | iL | 0 | 59 | 24 | . | ... | ... | .. | ... | |
| | | M | 1 | 03 | 48 | ... | ... | 220 | ... | ... | |
| | | F | 1 | 48 | 00 | ... | ... | ... | ... | ... | |
| 17 | 16 .. | eP | 11 | 53 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 12 | 01 | 00 | .. | ... | ... | ... | ... | |
| 18 | 21 ... | eP | 4 | 48 | 18 | .. | ... | ... | ... | ... | Widening of line. |
| | | F | 4 | 57 | 12 | ... | ... | ... | ... | ... | |
| 19 | 21 .. | eP | 8 | 54 | 00 | . | ... | .. | .. | ... | Widening of line. |
| | | F | 8 | 55 | 00 | .. | | ... | . | ... | |

| No. | Date. | | Phase. | Time G.M.T. H. | M. | S. | Period. (Sec.) | Amplitude ($\mu$) An. | Ae. | Az. | Distance. $\Delta$ (Km.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1918. | | | | | | | | | | |
| 20 | April | 21–22 ... | eP | 23 | 31 | 00 | ... | ... | ... | ... | ... | |
| | | | eL | 23 | 46 | 54 | ... | ... | | ... | ... | |
| | | | M | 23 | 50 | 42 | ... | ... | 60 | ... | ... | |
| | | | F | 1 | 23 | 00 | ... | ... | ... | ... | ... | |
| 21 | | 23 ... | eP | 15 | 55 | 54 | ... | ... | ... | ... | ... | Widening of line |
| | | | F | 16 | 04 | 06 | ... | ... | ... | ... | ... | |
| 22 | May | 4 ... | eP | 6 | 23 | 06 | ... | ... | ... | ... | ... | |
| | | | eL | 6 | 30 | 48 | ... | ... | ... | ... | ... | |
| | | | M | 6 | 35 | 54 | ... | ... | 80 | | ... | |
| | | | F | 6 | 53 | 42 | ... | ... | ... | ... | ... | |
| 23 | | 19 ... | P | ...... | | | ... | ... | ... | ... | ... | |
| | | | iL | 0 | 29 | 24 | ... | ... | | ... | ... | |
| | | | M | 0 | 32 | 48 | ... | ... | 100 | ... | ... | |
| | | | F | 0 | 42 | 36 | ... | ... | ... | ... | ... | |
| 24 | | 20 ... | eP | 15 | 04 | 30 | ... | ... | ... | ... | ... | |
| | | | eL | 15 | 33 | 06 | ... | ... | ... | ... | ... | |
| | | | M | 15 | 43 | 30 | ... | ... | 150 | ... | ... | |
| | | | F | 17 | 10 | 18 | ... | ... | ... | ... | ... | |
| 25 | | 20 ... | eP | 18 | 14 | 24 | ... | ... | ... | ... | ... | |
| | | | eL | 19 | 11 | 36 | ... | ... | ... | ... | ... | |
| | | | M | 19 | 22 | 18 | ... | ... | 90 | ... | ... | |
| | | | F | 19 | 40 | 12 | ... | ... | ... | ... | ... | |
| 26 | | 21 ... | eP | 0 | 49 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 0 | 50 | 24 | ... | ... | ... | | ... | |
| 27 | | 21 ... | eP | 0 | 56 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 0 | 59 | 36 | ... | ... | ... | ... | ... | |
| 28 | | 21 ... | eP | 1 | 13 | 54 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 1 | 16 | 30 | ... | ... | ... | ... | ... | |
| 29 | | 21 ... | eP | 12 | 24 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 12 | 25 | 42 | ... | ... | ... | ... | ... | |
| 30 | | 21 ... | eP | 13 | 36 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 13 | 38 | 12 | ... | ... | ... | ... | ... | |
| 31 | | 21 ... | eP | 13 | 49 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 13 | 51 | 24 | ... | ... | ... | ... | ... | |
| 32 | | 21 ... | eP | 14 | 33 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 14 | 35 | 06 | ... | ... | ... | ... | ... | |
| 33 | | 21 ... | eP | 14 | 39 | 42 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 14 | 41 | 12 | ... | ... | ... | ... | ... | |
| 34 | | 21 ... | eP | 15 | 04 | 42 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 15 | 05 | 42 | ... | ... | ... | ... | ... | |
| 35 | | 21 ... | eP | 17 | 55 | 36 | | ... | ... | ... | ... | Widening of line. |
| | | | F | 18 | 00 | 48 | ... | ... | ... | | ... | |
| 36 | | 21 ... | eP | 20 | 20 | 00 | | ... | ... | ... | ... | Widening of line. |
| | | | F | 20 | 22 | 06 | ... | ... | ... | ... | ... | |
| 37 | | 22 ... | eP | 3 | 33 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 3 | 36 | 06 | ... | ... | ... | ... | ... | |
| 38 | | 22 ... | eP | 6 | 55 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 6 | 57 | 30 | ... | ... | ... | ... | ... | |
| 39 | | 22 ... | eP | 7 | 01 | 30 | ... | ... | | ... | ... | Widening of line. |
| | | | F | 7 | 03 | 36 | | ... | ... | ... | ... | |
| 40 | | 22 ... | eP | 7 | 38 | 06 | | ... | ... | ... | ... | Widening of line. |
| | | | F | 7 | 42 | 12 | ... | ... | ... | ... | ... | |
| 41 | | 22 ... | eP | 16 | 32 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 16 | 34 | 06 | ... | ... | ... | ... | ... | |
| 42 | | 22 ... | eP | 23 | 36 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 23 | 39 | 12 | ... | ... | ... | ... | ... | |
| 43 | | 23 ... | eP | 1 | 31 | 00 | ... | ... | ... | | ... | Widening of line. |
| | | | F | 1 | 34 | 00 | | ... | ... | ... | ... | |
| 44 | | 23 ... | eP | 2 | 47 | 18 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 2 | 50 | 18 | ... | ... | ... | ... | ... | |
| 45 | | 23 ... | eP | 10 | 48 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 10 | 52 | 30 | ... | ... | ... | ... | ... | |
| 46 | | 23 ... | eP | 13 | 18 | 00 | ... | ... | ... | | ... | |
| | | | eL | 13 | 24 | 36 | ... | ... | ... | ... | ... | |
| | | | M | 13 | 30 | 18 | ... | | 50 | ... | ... | |
| | | | F | 14 | 35 | 06 | ... | ... | ... | ... | ... | |
| 47 | | 24 ... | eP | 2 | 47 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 2 | 55 | 30 | ... | ... | ... | ... | ... | |
| 48 | | 25 ... | eP | 20 | 11 | 18 | ... | ... | ... | ... | ... | |
| | | | eL | 20 | 54 | 48 | ... | ... | ... | ... | ... | |
| | | | M | 20 | 56 | 48 | ... | | 40 | ... | ... | |
| | | | F | 21 | 34 | 48 | ... | ... | ... | ... | ... | |
| 49 | | 30 ... | eP | 5 | 31 | 00 | | ... | ... | ... | ... | Widening of line. |
| | | | F | 5 | 36 | 12 | ... | ... | ... | ... | ... | |
| 50 | June | 1 ... | eP | 15 | 22 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 15 | 35 | 24 | ... | ... | ... | ... | ... | |
| 51 | | 3 ... | P | ...... | | | ... | ... | ... | ... | ... | |
| | | | eL | 0 | 56 | 24 | ... | ... | ... | ... | ... | |
| | | | M | 1 | 00 | 30 | ... | ... | 60 | ... | ... | |
| | | | F | 1 | 21 | 54 | | ... | ... | ... | ... | |

| No | Date | | Phase | Time G M T | | | Period (Sec) | Amplitude ($\mu$) | | | Distance $\Delta$ (Km) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | An | Ae | Az | | |
| | 1918 | | | H | M | S | | | | | | |
| 52 | June | 1 | eP | 4 | 55 | 36 | | | | | | Widening of line |
| | | | F | 4 | 59 | 42 | | | | | | |
| 53 | | 4 | eP | 18 | 09 | 30 | | | | | | |
| | | | eL | 18 | 16 | 06 | | | | | | |
| | | | M | 18 | 23 | 30 | | | 40 | | | |
| | | | F | 18 | 39 | 42 | | | | | | |
| 54 | | 8 | eP | 20 | 33 | 06 | | | | | | Widening of line |
| | | | F | 20 | 41 | 12 | | | | | | |
| 55 | | 26 | P | 22 | 31 | 00? | | | | | | Widening of line In continuation of hour mark |
| | | | F | 22 | 35 | 06 | | | | | | |
| 56 | July | 1 | eP | 6 | 17 | 12 | | | | | | |
| | | | eL | 6 | 28 | 30 | | | | | | |
| | | | M | 6 | 44 | 24 | | | 100 | | | |
| | | | F | 7 | 59 | 42 | | | | | | |
| 57 | | 3 | eP | 7 | 02 | 48 | | | | | | |
| | | | eL | 7 | 08 | 00 | | | | | | |
| | | | M | 7 | 37 | 42 | | | 350 | | | |
| | | | F | 9 | 21 | 18 | | | | | | |
| 58 | | 8 | P | | ... | | | | | | | Very destructive in Assam |
| | | | iL | 10 | 26 | 24 | | | | | | |
| | | | M | 10 | 31 | 30 | | | 1400 | | | |
| | | | F | 12 | 02 | 18 | | | | | | |
| 59 | | 15 | eP | 20 | 24 | 54 | | | | | | Widening of line. |
| | | | F | 20 | 41 | 12 | | | | | | |
| 60 | | 21 | eP | 6 | 29 | 30 | | | | | | |
| | | | eL | 6 | 32 | 00 | | | | | | |
| | | | M | 7 | 02 | 48 | | | 10 | | | |
| | | | F | 8 | 58 | 42 | | | | | | |
| 61 | | 21 | P | | | | | | | | | |
| | | | eL | 11 | 57 | 42 | | | | | | |
| | | | M | 12 | 01 | 48 | | | 70 | | | |
| | | | F | 12 | 17 | 12 | | | | | | |
| 62 | | 29 | eP | 12 | 12 | 00 | | | | | | Widening of line |
| | | | F | 12 | 21 | 18 | | | | | | |
| 63 | | 29 | eP | 12 | 36 | 12 | | | | | | Widening of line |
| | | | F | 12 | 44 | 24 | | | | | | |
| 64 | | 29 | eP | 12 | 59 | 42 | | | | | | Widening of line |
| | | | F | 13 | 01 | 48 | | | | | | |
| 65 | | 29 | eP | 15 | 09 | 18 | | | | | | Widening of line. |
| | | | F | 15 | 11 | 54 | | | | | | |
| 66 | | 29 | eP | 16 | 16 | 18 | | | | | | Widening of line |
| | | | F | 18 | 07 | 30 | | | | | | |
| 67 | | 29 | eP | 22 | 57 | 30 | | | | | | Widening of line |
| | | | F | 23 | 01 | 30 | | | | | | |
| 68 | | 31 | eP | 16 | 09 | 30 | | | | | | Widening of line |
| | | | F | 16 | 28 | 30 | | | | | | |
| 69 | August | 5 | eP | 2 | 38 | 06 | | | | | | Widening of line |
| | | | F | 2 | 54 | 24 | | | | | | |
| 70 | | 8 | eP | 10 | 38 | 12 | | | | | | Widening of line. |
| | | | F | 10 | 59 | 36 | | | | | | |
| 71 | | 12 | eP | 5 | 16 | 48 | | | | | | Widening of line. |
| | | | F | 5 | 20 | 54 | | | | | | |
| 72 | | 14 | eP | 14 | 44 | 24 | | | | | | Widening of line |
| | | | F | 14 | 56 | 42 | | | | | | |
| 73 | | 14 | eP | 17 | 25 | 12 | | | | | | Widening of line |
| | | | F | 17 | 28 | 12 | | | | | | |
| 74 | | 14 | eP | 18 | 35 | 06 | | | | | | Widening of line. |
| | | | F | 18 | 54 | 42 | | | | | | |
| 75 | | 15* | iP | 12 | 26 | 00 | | | | | | |
| | | | eL | 12 | 32 | 18 | | | | | | |
| | | | M | 12 | 53 | 00 | | | 1300± | | | |
| | | | F | 18 | 56 | 36 | | | | | | |
| 76 | | 16 | eP | 3 | 41 | 12 | | | | | | |
| | | | eL | 3 | 55 | 30 | | | | | | |
| | | | M | 3 | 58 | 24 | | | 60 | | | |
| | | | F | 4 | 13 | 06 | | | | | | |
| 77 | | 16 | eP | 8 | 51 | 24 | | | | | | |
| | | | eL | 8 | 55 | 18 | | | | | | |
| | | | M | 9 | 11 | 54 | | | 30 | | | |
| | | | F | 9 | 16 | 30 | | | | | | |
| 78 | | 17 | eP | 8 | 18 | 00 | | | | | | Widening of line |
| | | | F | 8 | 27 | 12 | | | | | | |
| 79 | | 23 | eP | 6 | 25 | 36 | | | | | | Widening of line |
| | | | F | 6 | 33 | 18 | | | | | | |
| 80 | | 23 | eP | 6 | 59 | 24 | | | | | | A single bead-like record |
| | | | F | 7 | 01 | 24 | | | 50 | | | |
| 81 | | 23 | eP | 7 | 32 | 00 | | | | | | |
| | | | eL | 7 | 38 | 42 | | | | | | |

* There was a lull between $16^h\frac{1}{2}$ and $17^h\frac{1}{2}$.

At $12^h\,56^m{\cdot}3$ the boom had moved east 8·5mm but instead of oscillating in the usual way moved westwards very slowly 2mm in a minute and a half. The usual oscillations were resumed at $12^h\,57^m{\cdot}8$

| No | Date | Phase | Time G M T H | M | S | Period (Sec) | Amplitude ($\mu$) AN | AE | AZ | Distance △ (Km) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 81—cont. | 1918 August 23—cont | M | 7 | 44 | 18 | | | 50 | | | |
| | | F | 8 | 00 | 24 | | | | | | |
| 82 | 31 | eP | 22 | 14 | 42 | | | | | | Widening of line. |
| | | F | 22 | 27 | 12 | | | | | | |
| 83 | September 2 | eP | 14 | 54 | 36 | | | | | | Widening of line |
| | | F | 15 | 11 | 30 | | | | | | |
| 84 | 5 | eP | 7 | 31 | 00 | | | | | | Widening of line. |
| | | F | 7 | 43 | 18 | | | | | | |
| 85 | 7 | iP | 17 | 29 | 30 | | | | | | |
| | | iL | 17 | 37 | 42 | | | | | | |
| | | M | 18 | 07 | 12 | | | 1420 | | | |
| | | F | 22 | 08 | 00 | | | | | | |
| 86 | 8 | eP | 0 | 35 | 06 | | | | | | Widening of line. |
| | | F | 1 | 06 | 54 | | | | | | |
| 87 | 8 | eP | 6 | 31 | 00 | | | | | | Widening of line. |
| | | F | 6 | 45 | 18 | | | | | | |
| 88 | 11 | eP | 4 | 24 | 54 | | | | | | Widening of line. |
| | | F | 4 | 44 | 24 | | | | | | |
| 89 | 13 | eP | 2 | 56 | 48 | | | | | | Widening of line |
| | | F | 2 | 59 | 36 | | | | | | |
| 90 | 16 | eP | 6 | 22 | 54 | | | | | | Widening of line. |
| | | F | 6 | 27 | 00 | | | | | | |
| 91 | 22 | iP | 10 | 05 | 24 | | | | | | |
| | | eL | 10 | 09 | 00 | | | | | | |
| | | M | 10 | 11 | 00 | | | 250 | | | |
| | | F | 10 | 33 | 36 | | | | | | |
| 92 | 28 | eP | 11 | 51 | 24 | | | | | | Widening of line |
| | | F | 11 | 55 | 30 | | | | | | |
| 93 | 29 | eP | 12 | 26 | 54 | | | | | | |
| | | eL | 12 | 35 | 54 | | | | | | |
| | | M | 12 | 38 | 42 | | | 160 | | | |
| | | F | 12 | 54 | 36 | | | | | | |
| 94 | 30 | eP | 18 | 41 | 48 | | | | | | |
| | | eL | 18 | 48 | 12 | | | | | | |
| | | M | 18 | 54 | 06 | | | 110 | | | |
| | | F | 19 | 45 | 54 | | | | | | |
| 95 | October 1 | eP | 1 | 15 | 54 | | | | | | |
| | | iL | 1 | 30 | 12 | | | | | | |
| | | M | 1 | 30 | 12 | | | 80 | | | |
| | | F | 2 | 19 | 42 | | | | | | |
| 96 | 1 | eP | 8 | 06 | 18 | | | | | | Widening of line. |
| | | F | 8 | 09 | 18 | | | | | | |
| 97 | 9 | eP | 9 | 32 | 00 | | | | | | Widening of line. |
| | | F | 9 | 55 | 06 | | | | | | |
| 98 | 11 | eP | 14 | 38 | 00 | | | * | | | |
| | | eL | 15 | 36 | 42 | | | | | | |
| | | M | 15 | 42 | 48 | | | 130 | | | |
| | | F | 16 | 45 | 54 | | | | | | |
| 99 | 16 | eP | 20 | 25 | 54 | | | | | | Widening of line |
| | | F | 20 | 43 | 06 | | | | | | |
| 100 | 25 | eP | 5 | 10 | 30 | | | | | | Widening of line |
| | | F | 5 | 26 | 42 | | | | | | |
| 101 | 27 | eP | 15 | 49 | 48 | | | | | | |
| | | eL | 16 | 24 | 42 | | | | | | |
| | | M | 16 | 27 | 42 | | | 40 | | | |
| | | F | 16 | 39 | 00 | | | | | | |
| 102 | 27 | iP | 17 | 27 | 00 | | | | | | |
| | | iL | 17 | 41 | 00 | | | | | | |
| | | M | 18 | 01 | 54 | | | 100 | | | |
| | | F | 18 | 34 | 42 | | | | | | |
| 103 | November 3 | eP | 11 | 32 | 00 | | | | | | Widening of line |
| | | F | 12 | 25 | 06 | | | | | | |
| 104 | 8 | eP | 4 | 50 | 00 | | | | | | |
| | | iL | 4 | 59 | 06 | | | | | | |
| | | M | 5 | 28 | 48 | | | 840 | | | |
| | | F | 8 | 23 | 06 | | | | | | |
| 105 | 10 | eP | 17 | 41 | 42 | | | | | | Widening of line. |
| | | | 17 | 43 | 48 | | | | | | |
| 106 | 10 | eP | 18 | 26 | 24 | | | | | | Widening of line. |
| | | | 18 | 28 | 24 | | | | | | |
| 107 | 10 | eP | 18 | 49 | 24 | | | | | | Widening of line. |
| | | | 18 | 50 | 54 | | | | | | |
| 108 | 11 | eP | 7 | 44 | 18 | | | | | | Widening of line. |
| | | | 7 | 52 | 00 | | | | | | |
| 109 | 12 | eP | 23 | 08 | 18 | | | | | | Widening of line. |
| | | | 23 | 25 | 06 | | | | | | |
| 110 | 18 | iP | 18 | 50 | 36 | | | | | | |
| | | iL | 18 | 58 | 36 | | | | | | |
| | | M | 19 | 14 | 00 | | | 650 | | | |
| | | F | 22 | 17 | 00 | | | | | | |

* The amplitude was comparatively large, namely 0 6mm, from 14h 38m·5 to 14h 40m 5

| No | Date. | Phase | Time G.M.T. | | | Period. (Sec.). | Amplitude (u). | | | Distance Δ (Km.) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | H. | M. | S. | | An | Ae | Az | | |
| | 1918. | | | | | | | | | | |
| 111 | November 22 ... | eP | 16 | 36 | 06 | .. | | . | ... | ... | Widening of line. |
| | | F | 16 | 42 | 48 | | ... | .. | | . | |
| 112 | 23–24 ... | eP | 23 | 06 | 36 | . | | | ... | ... | |
| | | eL | 23 | 10 | 00 | ... | .. | 80 | ... | ... | |
| | | M | 23 | 35 | 06 | | .. | ... | ... | ... | |
| | | F | 0 | 13 | 54 | .. | ... | ... | | ... | |
| 113 | 28 ... | eP | 9 | 58 | 42 | ... | | ... | ... | ... | Widening of line. |
| | | F | 10 | 00 | 36 | ... | .. | ... | .. | ... | |
| 114 | 29 ... | eP | 10 | 54 | 06 | ... | | | .. | ... | Widening of line. |
| | | F | 11 | 02 | 42 | . | ... | ... | .. | ... | |
| 115 | 30 ... | P | ... | | | ... | ... | ... | .. | .. | No P.Ts. |
| | | iL | 7 | 26 | 12 | ... | .. | .. | .. | .. | |
| | | M | 7 | 26 | 24 | . | | 60 | . | ... | |
| | | F | 7 | 41 | 12 | ... | .. | | ... | ... | |
| 116 | December 1 ... | eP | 2 | 46 | 06 | ... | ... | . | ... | ... | |
| | | iL | 2 | 50 | 12 | ... | | .. | .. | ... | |
| | | M | 2 | 51 | 06 | . | ... | 480 | | . | |
| | | F | 3 | 32 | 00 | ... | ... | ... | .. | ... | |
| 117 | 2 ... | eP | 10 | 18 | 42 | ... | ... | ... | ... | ... | |
| | | eL | 10 | 48 | 24 | | .. | ... | ... | ... | |
| | | M | 10 | 59 | 00 | ... | ... | 400 | . | | |
| | | F | 11 | 57 | 48 | ... | ... | .. | ... | ... | |
| 118 | 4 . | e | 7 | 43 | 18 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 7 | 47 | 24 | ... | ... | .. | ... | ... | |
| 119 | 4 ... | eP | 12 | 08 | 18 | | ... | ... | ... | ... | |
| | | iL | 13 | 00 | 42 | .. | ... | | ... | ... | |
| | | M | 13 | 18 | 06 | ... | .. | 760 | ... | ... | |
| | | F | 15 | 27 | 12 | ... | ... | ... | ... | .. | |
| 120 | 4 ... | eP | 19 | 04 | 42 | ... | .. | .. | ... | ... | Widening of line. |
| | | F | 19 | 12 | 54 | ... | ... | .. | .. | ... | |
| 121 | 6 ... | eP | 8 | 43 | 18 | ... | ... | ... | ... | .. | Widening of line. |
| | | F | 10 | 42 | 48 | ... | ... | ... | ... | ... | |
| 122 | 9 ... | eP | 18 | 52 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 20 | 06 | 48 | .. | ... | . | ... | ... | |
| 123 | 18 ... | eP | 21 | 44 | 06 | ... | ... | ... | ... | ... | A single shock. |
| | | F | 21 | 50 | 24 | ... | . | 50 | ... | ... | |
| 124 | 19 ... | eP | 20 | 30 | 00 ? | ... | ... | ... | ... | ... | Widening of line. Beginning lost in hour mark. |
| | | F | 20 | 38 | 12 | ... | ... | ... | ... | ... | |
| 125 | 20 ... | eP | 6 | 55 | 36 | | ... | ... | ... | ... | Widening of line. |
| | | F | 6 | 56 | 42 | .. | .. | .. | ... | ... | |
| 126 | 25 ... | eP | 10 | 42 | 06 | ... | ... | ... | ... | ... | Widening of line Amplitude was 0·3$^{mm}$ at 10$^{h}$ 42·5$^{m}$ |
| | | F | 11 | 21 | 18 | ... | ... | ... | ... | ... | |
| 127 | 31 ... | eP | 8 | 34 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 8 | 37 | 12 | ... | . | ... | ... | ... | |

# APPENDIX II.

Latitude 10° 13′ 50″ N.

Longitude $5^h\ 9^m\ 52^s$ E.

Height of Barometer cistern above mean sea level 7688 feet.

## MEAN Monthly and Annual Meteorological Results at the Kodaikanal Observatory in 1918.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily Range. | Dry Bulb Thermometer. Mean. | Dry Bulb Thermometer. Max. | Dry Bulb Thermometer. Min. | Dry Bulb Thermometer. Range. | Wet Bulb. Mean. | Wet Bulb. Min. | Tension of Vapour. By Simpson's Tables. | Relative Humidity. By Simpson's Tables. | Sun Max. in Vac. | Min. on Grass. | Wind. Daily Velocity | Wind. Mean Direction. | Wind. Mean Direction. | Rain. Amount. | Rain. Days. | Clear Sky. | Bright Sun shine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Inches. | ° | ° | ° | ° | ° | ° | Inches. | Cents. | ° | ° | Miles. | Points | Points. | Inches. | No. | Cents. | Hours. |
| January | 22·805 | 0·065 | 53·1 | 61·0 | 45·2 | 15·8 | 48·3 | 42·1 | 0·303 | 76 | 115·9 | 38·0 | 289 | 3 | N. E. by N. | 6·08 | 8 | 44 | 210·1 |
| February | ·860 | ·060 | 54·1 | 64·8 | 43·5 | 21·3 | 44·9 | 38·1 | ·219 | 54 | 125·7 | 33·8 | 316 | 1 | N. by E. | 0·57 | 1 | 83 | 283·5 |
| March | ·847 | ·056 | 58·2 | 68·5 | 47·9 | 20·6 | 48·0 | 41·3 | ·243 | 52 | 132·2 | 39·7 | 308 | 5 | N. E. by E. | 1·02 | 5 | 79 | 297·5 |
| April | ·841 | ·058 | 62·2 | 72·4 | 52·0 | 20·4 | 51·9 | 46·4 | ·292 | 56 | 135·2 | 43·6 | 269 | 7 | E by N. | 2·12 | 3 | 74 | 282·6 |
| May | ·755 | ·063 | 60·0 | 66·7 | 53·4 | 13·3 | 55·1 | 50·5 | ·396 | 80 | 125·9 | 49·0 | 329 | 17 | S. by W. | 5·14 | 11 | 25 | 141·4 |
| June | ·775 | ·057 | 58·9 | 66·1 | 51·7 | 14·4 | 53·7 | 47·8 | ·370 | 76 | 127·3 | 45·8 | 253 | 24 | West | 5·90 | 10 | 41 | 198·3 |
| July | ·797 | ·043 | 59·3 | 66·8 | 51·7 | 15·1 | 53·1 | 47·5 | ·355 | 73 | 129·6 | 45·2 | 287 | 21 | S. W. by W. | 2·94 | 5 | 42 | 201·7 |
| August | ·785 | ·057 | 58·3 | 65·1 | 51·5 | 13·6 | 53·8 | 48·7 | ·383 | 82 | 126·2 | 45·9 | 300 | 25 | W. by N. | 5·73 | 11 | 27 | 163·1 |
| September | ·822 | ·062 | 58·2 | 65·4 | 51·1 | 14·3 | 53·5 | 48·1 | ·373 | 79 | 126·7 | 43·6 | 188 | 20 | S. W. | 1·94 | 4 | 34 | 163·6 |
| October | ·849 | ·060 | 57·7 | 64·9 | 50·5 | 14·4 | 53·3 | 48·4 | ·372 | 81 | 127·0 | 44·6 | 227 | 1 | N. by E. | 7·08 | 17 | 41 | 201·7 |
| November | ·813 | ·072 | 56·3 | 61·2 | 51·5 | 9·7 | 53·9 | 50·5 | ·403 | 92 | 112·2 | 47·9 | 255 | 6 | E. N. E. | 14·00 | 20 | 15 | 95·6 |
| December | ·851 | ·062 | 54·5 | 61·1 | 47·9 | 13·2 | 49·1 | 44·0 | ·301 | 74 | 115·1 | 42·7 | 297 | 3 | N. E. by N. | 4·85 | 9 | 36 | 160·3 |
| Annual | 22·817 | 0·060 | 57·6 | 65·3 | 49·8 | 15·5 | 51·5 | 46·1 | 0·334 | 73 | 125·0 | 43·3 | 276 | 30 | N. N. W. | 57·37 | 104 | 45 | 2399·4 |

## EXTREME Monthly Meteorological Records at the Kodaikanal Observatory in 1918.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry Bulb Thermometer. Highest. | | Dry Bulb Thermometer. Lowest. | | Wet Bulb. Lowest. | | Humidity. Lowest. | | Sun Th. in Vacuo. Highest. | | Grass Therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest Fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Day. | Inches. | Day. | Inches. | ° | Day. | ° | Day. | ° | Day. | Cents. | Day. | ° | Day. | ° | Day. | Miles. | Day. | Miles. | Day. | Inches. | Day. |
| January | 22·879 | 4 | 22·720 | 17 | 0·159 | 68·4 | 1 | **37·2** | **29** | **32·2** | **29** | 23 | 17&29 | 133·1 | 10 | 28·0 | 30 | **740** | **27** | 104 | 21 | **2·48** | **27** |
| February | **·945** | **25** | ·774 | 5 | ·171 | 70·6 | 10 | 40·3 | 4 | 33·2 | 21 | 12 | 11 | 135·9 | 16&26 | **23·0** | **3** | 485 | 12 | 178 | 1 | 0·45 | 23 |
| March | ·916 | 9 | ·764 | 24 | ·152 | 74·2 | 20 | 44·2 | 3 | 34·1 | 4 & 8 | 12 | 29 | 140·6 | 15 | 32·1 | 4 | 511 | 29 | 153 | 22 | 0·37 | 27 |
| April | ·931 | 30 | ·757 | 3 | ·174 | **76·4** | **18** | 47·7 | 1 | 37·1 | 1 | 14 | 1 | 143·1 | 8 | 35·6 | 1 | 430 | 25 | 173 | 4 | 1·76 | 29 |
| May | ·839 | 1 | **·674** | **17** | ·165 | 74·4 | 2 | 49·8 | 7 | 43·9 | 1 | 36 | 2 | 141·9 | 15 | 43·5 | 31 | 580 | 21 | 92 | 31 | 1·67 | 8 |
| June | ·866 | 5 | ·677 | 29 | ·189 | 69·8 | 20 | 47·3 | 7 | 39·9 | 8 | 38 | 8 & 9 | 136·6 | 10&28 | 38·9 | 7 | 454 | 18 | **85** | **1** | 1·17 | 5 |
| July | ·854 | 9 | ·716 | 1 | ·138 | 72·3 | 8 | 49·2 | 5 & 31 | 41·1 | 8 | 32 | 8 | 145·1 | 12 | 40·3 | 11 | 590 | 29 | 108 | 14 | 1·05 | 27 |
| August | ·876 | 11 | ·699 | 28 | ·177 | 69·4 | 8 | 49·4 | 16 | 43·6 | 12 & 14 | 53 | 14 | 140·9 | 13 | 40·3 | 7 | 478 | 16 | 128 | 23 | 1·40 | 10 |
| September | ·908 | 18 | ·744 | 4 | ·164 | 69·2 | 26 | 49·2 | 22 | 42·0 | 23 | 42 | 26 | **148·4** | **24** | 39·4 | 7 | 399 | 24 | 88 | 5 | 0·76 | 17 |
| October | ·909 | 11 | ·786 | 31 | ·123 | 68·7 | 4 & 5 | 45·2 | 26 | 41·2 | 26 | 26 | 26 | 141·6 | 30 | 35·1 | 26 | 373 | 21 | 109 | 13 | 1·05 | 20 |
| November | ·906 | 30 | ·710 | 17 | ·196 | 64·9 | 13 | 47·0 | 9 | 42·9 | 10 | 46 | 9 | 141·0 | 13 | 39·2 | 9 | 493 | 17 | 118 | 22 | 1·85 | 13 |
| December | ·918 | 4,19 & 20 | ·752 | 9 | ·166 | 67·8 | 30 | 41·3 | 23 | 35·3 | 30 | **7** | **9** | 136·3 | 9 | 29·1 | 23 | 490 | 9 | 171 | 13 | 0·95 | 18 |

# APPENDIX III.

KODAIKANAL mean hourly wind velocity for the year 1918.

| Month. | Hours | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| January | 14 | 14 | 14 | 14 | 14 | 13 | 13 | 13 | 13 | 14 | 13 | 12 | 12 | 11 | 9 | 9 | 8 | 9 | 10 | 11 | 12 | 11 | 13 | 12 |
| February | 15 | 15 | 15 | 16 | 15 | 14 | 14 | 14 | 14 | 15 | 16 | 16 | 14 | 11 | 11 | 9 | 8 | 8 | 9 | 11 | 12 | 13 | 14 | 15 |
| March | 15 | 15 | 15 | 15 | 15 | 14 | 15 | 14 | 15 | 15 | 16 | 15 | 13 | 13 | 12 | 10 | 9 | 8 | 8 | 9 | 9 | 11 | 14 | 14 |
| April | 10 | 10 | 10 | 10 | 10 | 11 | 12 | 12 | 13 | 14 | 16 | 14 | 13 | 11 | 11 | 11 | 10 | 9 | 10 | 11 | 9 | 9 | 10 | 11 |
| May | 14 | 14 | 15 | 16 | 15 | 15 | 15 | 14 | 12 | 13 | 13 | 13 | 12 | 12 | 12 | 13 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 14 |
| June | 13 | 12 | 12 | 12 | 12 | 12 | 12 | 10 | 9 | 8 | 9 | 9 | 9 | 9 | 8 | 9 | 9 | 10 | 11 | 12 | 12 | 12 | 11 | 11 |
| July | 13 | 13 | 12 | 13 | 12 | 13 | 12 | 11 | 11 | 12 | 11 | 10 | 11 | 11 | 11 | 11 | 10 | 12 | 13 | 13 | 12 | 13 | 14 | 13 |
| August | 15 | 10 | 15 | 14 | 14 | 14 | 13 | 12 | 11 | 11 | 11 | 11 | 10 | 11 | 10 | 10 | 11 | 12 | 12 | 13 | 13 | 14 | 14 | 15 |
| September | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 8 | 7 | 8 | 7 | 7 | 8 | 8 | 8 |
| October | 9 | 10 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 12 | 11 | 10 | 9 | 9 | 9 | 8 | 8 | 8 | 7 | 8 | 8 | 8 | 8 | 9 |
| November | 12 | 12 | 12 | 12 | 11 | 11 | 12 | 12 | 11 | 11 | 12 | 11 | 11 | 10 | 9 | 8 | 8 | 8 | 9 | 10 | 10 | 10 | 11 | 12 |
| December | 14 | 13 | 14 | 13 | 13 | 13 | 14 | 13 | 13 | 13 | 13 | 13 | 12 | 11 | 10 | 9 | 8 | 10 | 12 | 13 | 13 | 13 | 14 | 14 |
| Mean | 13 | 12 | 13 | 13 | 13 | 12 | 13 | 12 | 12 | 12 | 12 | 12 | 11 | 11 | 10 | 10 | 9 | 9 | 10 | 11 | 11 | 11 | 12 | 12 |

## APPENDIX IV.

KODAIKANAL mean hourly bright sunshine for the year 1918.

| Month. | Hours. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6–7 | 7–8 | 8–9 | 9–10 | 10–11 | 11–12 | 12–13 | 13–14 | 14–15 | 15–16 | 16–17 | 17–18 |
| January | 0·36 | 0·76 | 0·82 | 0·78 | 0·76 | 0 74 | 0·67 | 0·59 | 0·51 | 0·45 | 0·29 | 0·05 |
| February | ·56 | ·92 | ·93 | ·93 | ·95 | ·94 | ·92 | ·93 | ·85 | ·87 | ·81 | ·53 |
| March | ·53 | ·92 | ·97 | ·97 | ·97 | ·92 | ·87 | ·82 | ·79 | ·74 | ·72 | ·37 |
| April | ·48 | ·96 | ·99 | 1·00 | 1·00 | ·98 | ·94 | ·89 | ·77 | ·64 | ·51 | ·26 |
| May | ·14 | ·37 | ·46 | 0·56 | 0·56 | ·68 | ·49 | ·40 | ·34 | ·32 | ·18 | ·07 |
| June | ·22 | ·76 | ·88 | ·91 | ·87 | ·77 | ·71 | ·51 | ·33 | ·32 | ·23 | ·09 |
| July | ·27 | ·71 | ·80 | ·80 | ·80 | 72 | ·63 | ·52 | ·53 | ·45 | ·23 | ·05 |
| August | ·20 | ·60 | ·72 | ·71 | ·64 | ·55 | ·46 | ·42 | ·40 | ·29 | ·20 | ·08 |
| September | ·27 | ·64 | ·81 | ·78 | ·75 | ·57 | ·52 | ·36 | ·29 | ·23 | ·15 | ·07 |
| October | ·26 | ·67 | ·78 | ·79 | ·84 | ·75 | ·71 | ·54 | ·46 | ·36 | ·26 | ·10 |
| November | ·05 | ·23 | ·32 | ·31 | ·28 | ·37 | ·42 | ·38 | ·38 | ·26 | ·17 | ·02 |
| December | ·07 | ·40 | ·52 | ·61 | ·66 | ·58 | ·58 | ·55 | ·48 | ·39 | ·29 | ·02 |
| Mean | 0·28 | 0·66 | 0·75 | 0·76 | 0·76 | 0·71 | 0·66 | 0·58 | 0·51 | 0·44 | 0·34 | 0·14 |

## APPENDIX V.

NUMBER of days in each month on which the Nilgiris were visible in 1918.

| Month. | Very clear. | Visible. | Just visible. | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January | ... | 12 | 3 | .. | 15 |
| February | ... | 3 | 5 | ... | 8 |
| March | ... | 4 | 3 | ... | 7 |
| April | . | ... | ... | ... | ... |
| May | 2 | 5 | 2 | ... | 9 |
| June | 1 | 7 | ... | ... | 8 |
| July | . | 4 | 3 | ... | 7 |
| August | 1 | 3 | ... | ... | 4 |
| September | 2 | 8 | 2 | ... | 12 |
| October | . | 1 | 1 | ... | 2 |
| November | 2 | 5 | ... | ... | 7 |
| December | 2 | 13 | ... | 1 | 16 |
| Total | 10 | 65 | 19 | 1 | 95 |

## APPENDIX VI.

MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1918.

| Abnormals of | January. | February. | March. | April. | May. | June. | July. | August. | September | October. | November. | December. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure ... ... ... | − 0·052 | + 0·039 | + 0·008 | − 0·002 | − 0·043 | + 0·012 | + 0·023 | − 0·006 | + 0·023 | + 0·049 | − 0·049 | + 0·005 | + 0·001 |
| Temperature of air ... ... ... ... ... | + 0·4 | − 1·1 | − 0·7 | − 0·2 | − 0·5 | − 0·5 | + 2·4 | + 2·4 | + 1·3 | + 2·8 | + 1·2 | + 1·5 | + 0·8 |
| Do. of evaporation ... ... .. | + 2·3 | − 0·6 | + 0·5 | + 0·9 | + 0·8 | + 0·6 | + 0·8 | + 0·8 | + 2·2 | + 0·5 | + 3·2 | + 2·0 | + 1·1 |
| Percentage of humidity ... ... ... ... | + 8 | + 2 | + 4 | + 4 | + 5 | + 4 | − 4 | − 4 | + 5 | − 8 | + 9 | + 3 | + 2 |
| Greatest solar heat in vacuo ... ... ... | + 2·1 | + 11·2 | + 11·2 | + 10·4 | + 6·4 | + 4·8 | + 10·8 | + 11·8 | + 10·1 | + 16·4 | − 4·9 | + 9·5 | + 8·3 |
| Maximum in shade ... ... ... ... | − 2·8 | − 1·1 | − 1·4 | + 0·4 | − 1·5 | − 0·1 | + 3·4 | + 3·6 | + 1·3 | + 3·1 | − 1·3 | − 0·5 | + 0·3 |
| Minimum in shade .. ... ... ... ... | + 2·4 | − 1·7 | − 1·5 | − 1·0 | − 1·3 | − 1·1 | + 1·7 | + 1·6 | + 1·0 | − 0·2 | + 2·7 | + 2·2 | + 0·4 |
| Do. on grass ... ... ... ... | + 4·2 | − 0·6 | − 1·0 | − 1·0 | − 1·0 | − 0·9 | + 2·0 | + 2·1 | + 1·4 | − 0·4 | + 4·4 | + 3·5 | + 1·4 |
| Rainfall in inches . ... ... ... ... | + 7·16 | + 1·90 | − 0·37 | − 0·62 | + 3·68 | − 0·31 | − 3·22 | − 1·50 | − 1·44 | − 6·66 | + 25·97 | + 1·39 | .. |
| Do. since January 1st ... ... ... | ... | + 9·06 | + 8·69 | + 8·07 | + 11·75 | + 11·44 | + 8·22 | + 6·72 | + 5·28 | − 1·38 | + 24·59 | + 25·98 | + 25·98 |
| General direction of wind ... ... ... ... | 2 points N. | same as | same as | 1 point S. | 2 points W. | 1 point S. | 1 point S. | same as | same as | 1 point E. | 3 points E. | 1 point E. | same as |
| Daily velocity in miles ... ... ... ... | + 46 | − 29 | − 37 | − 5 | − 47 | − 86 | − 57 | − 74 | − 89 | − 52 | − 56 | − 68 | − 43 |
| Percentage of cloudy sky ... ... ... ... | + 15 | − 6 | − 9 | − 11 | + 8 | − 12 | − 21 | + 3 | same as | − 27 | + 17 | + 1 | − 4 |
| Do. of bright sunshine ... ... | − 17·6 | − 1·1 | same as | + 10·5 | − 4·6 | + 6·8 | + 13·0 | + 2·1 | − 5·1 | + 18·4 | − 26·0 | − 8·1 | − 5·5 |

+ means *above* normal ; − means *below* normal.

## APPENDIX VII.

ABSTRACT of the Mean Meteorological Condition of Madras in the year 1918 compared with the average of past years.

| Mean values of | 1918. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure ... .. .. ... | 29·865 | 0·001 above. | 29·864 |
| Temperature of air .. ... ... ... ... ... | 81·9 | 0·8 " | 81·1 |
| Do. of evaporation ... ... ... ... ... | 75·6 | 1·1 " | 74·5 |
| Percentage of humidity ... ... ... ... .. ... | 74 | 2 " | 72 |
| Greatest solar heat in *vacuo* ... ... ... ... .. | 148·0 | 8·3 " | 139·7 |
| Maximum in shade ... ... ... ... .. | 91·1 | 0·3 " | 90·8 |
| Minimum in shade ... ... ... ... ... .. | 75·1 | 0·4 " | 74·7 |
| Do. on grass . ... ... .. . ... | 73·3 | 1·4 " | 71·9 |
| Rainfall since January 1st on 88 days ... ... .. | 75·00 | 25·98 " | 49·02 |
| General direction of wind .. ... ... ... ... | S.E. | same as | S.E. |
| Daily velocity in miles ... ... ... ... ... ... | 128 | 43 below. | 171 |
| Percentage of cloudy sky ... ... ... ... ... | 45 | 4 " | 49 |
| Do. of bright sunshine ... ... ... ... ... | 52·9 | 5·5 " | 58·4 |

DURATION and quantity of the wind from different points.

| From | Hours. | Miles. | From | Hours. | Miles | From | Hours. | Miles. | From | Hours. | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North. | 228 | 1640 | East. | 240 | 936 | South. | 252 | 1415 | West. | 334 | 2487 |
| N. by E. | 289 | 2182 | E. by S. | 302 | 1288 | S. by W | 186 | 1031 | W. by N. | 172 | 1123 |
| N.N.E. | 221 | 1622 | E.S.E. | 135 | 621 | S.S.W. | 190 | 1163 | W.N.W. | 129 | 979 |
| N.E. by N. | 531 | 3178 | S.E. by E. | 400 | 1815 | S.W. by S. | 137 | 595 | N. W. by W. | 74 | 421 |
| N.E. | 226 | 1457 | S.E. | 589 | 3078 | S W. | 133 | 676 | N.W. | 41 | 280 |
| N.E. by E. | 108 | 736 | S.E. by S. | 709 | 4345 | S.W. by W. | 139 | 700 | N.W. by N. | 86 | 555 |
| E.N.E. | 79 | 461 | S.S.E. | 655 | 4849 | W.S.W | 217 | 1461 | N.N.W. | 53 | 363 |
| E. by N. | 207 | 942 | S. by E. | 280 | 1744 | W. by S. | 225 | 1392 | N. by W. | 144 | 1165 |

There were 1,049 calm hours during the year. The resultant corresponding to the above numbers is represented by a S.E. wind, blowing with a uniform daily velocity of 25 miles.

# APPENDIX VIII.

MADRAS OBSERVATORY.—Number of hours of wind from each point in the year 1918.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 81 | 64 | 147 | 214 | 56 | 14 | 10 | 10 | 24 | 7 | 1 | ... | ... | 20 | 4 | 18 | .. | ... | ... | ... | 1 | ... | ... | 11 | 1 | 8 | ... | 3 | 5 | 12 | 13 | 13 | 7 |
| February | ... | 19 | ... | 89 | 37 | 24 | 16 | 44 | 86 | 113 | 31 | 63 | 17 | 15 | 29 | 16 | 24 | 2 | 3 | 2 | ... | 2 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 6 | 34 |
| March | | ... | ... | ... | ... | ... | ... | 16 | 39 | 59 | 12 | 72 | 192 | 175 | 93 | 15 | 15 | 12 | 4 | 4 | ... | ... | ... | ... | | .. | .. | ... | | ... | ... | .. | 36 |
| April | ... | ... | ... | ... | ... | ... | .. | .. | ... | ... | ... | 10 | 60 | 254 | 249 | 39 | 30 | 29 | 33 | 7 | 3 | .. | 2 | 1 | ... | ... | .. | ... | ... | ... | ... | ... | 3 |
| May | ... | 1 | .. | ... | 2 | ... | . | 1 | ... | 1 | 1 | 36 | 125 | 68 | 86 | 32 | 32 | 25 | 20 | 17 | 32 | 25 | 61 | 30 | 76 | 20 | 19 | 18 | 1 | 9 | . | ... | 6 |
| June | ... | .. | .. | .. | 5 | ... | 1 | 1 | 6 | 17 | 13 | 26 | 48 | 19 | 80 | 55 | 70 | 37 | 51 | 11 | 25 | 27 | 52 | 32 | 66 | 26 | 28 | 6 | 10 | 4 | 2 | ... | 2 |
| July | 2 | 1 | 3 | 5 | ... | .. | 1 | ... | 2 | 3 | 8 | 41 | 30 | 58 | 49 | 57 | 26 | 30 | 23 | 29 | 34 | 33 | 42 | 60 | 65 | 49 | 33 | 23 | 2 | 7 | 1 | ... | 27 |
| August | 1 | ... | 1 | 1 | 1 | ... | 2 | 3 | 5 | 6 | 10 | 26 | 56 | 54 | 41 | 29 | 35 | 17 | 17 | 20 | 20 | 29 | 40 | 62 | 94 | 49 | 22 | 7 | 6 | 6 | 1 | ... | 83 |
| September | 2 | 2 | 2 | 1 | 7 | 4 | 4 | 4 | 11 | 16 | 21 | 58 | 33 | 31 | 16 | 17 | 5 | 21 | 34 | 34 | 16 | 17 | 20 | 28 | 30 | 20 | 25 | 16 | 16 | 16 | 14 | 2 | 177 |
| October | 15 | 27 | 3 | 18 | 25 | 20 | 20 | 48 | 41 | 49 | 30 | 59 | 25 | 8 | 6 | 1 | 5 | 3 | 4 | 1 | 2 | 4 | ... | ... | ... | . | .. | ... | .. | ... | 1 | 7 | 322 |
| November | 54 | 107 | 22 | 31 | 15 | 27 | 16 | 31 | 21 | 31 | 8 | 8 | 2 | 7 | 2 | 1 | 10 | 10 | 1 | 12 | ... | 2 | ... | 1 | 2 | ... | 2 | 1 | 1 | 32 | 20 | 62 | 181 |
| December | 73 | 68 | 43 | 172 | 78 | 19 | 9 | 49 | 5 | ... | ... | 1 | 1 | . | ... | .. | ... | ... | .. | .. | ... | ... | ... | ... | ... | . | ... | ... | .. | .. | 1 | 54 | 171 |
| Annual total. | 228 | 289 | 221 | 531 | 226 | 108 | 79 | 207 | 240 | 302 | 135 | 400 | 589 | 709 | 655 | 280 | 252 | 186 | 190 | 137 | 133 | 139 | 217 | 225 | 334 | 172 | 129 | 74 | 41 | 86 | 53 | 144 | 1049 |

# APPENDIX IX.

MADRAS OBSERVATORY.—Number of miles of wind from each point in the year 1918.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 718 | 697 | 1097 | 1476 | 386 | 141 | 106 | 98 | 124 | 49 | 8 | .. | | 80 | 34 | 66 | ... | ... | ... | ... | 6 | ... | ... | 80 | 12 | 52 | ... | 40 | 86 | 193 | 179 | 156 | 5884 |
| February | .. | 60 | ... | 354 | 230 | 147 | 86 | 179 | 306 | 399 | 133 | 225 | 55 | 86 | 99 | 70 | 108 | 12 | 18 | 11 | ... | 10 | ... | ... | .. | .. | ... | ... | .. | ... | . | 28 | 2616 |
| March | .. | . | | .. | ... | .. | ... | 81 | 156 | 226 | 52 | 305 | 910 | 940 | 540 | 113 | 93 | 77 | 38 | 25 | .. | ... | ... | ... | ... | ... | ... | .. | . | ... | . | .. | 3556 |
| April | . | | ... | ... | ... | . | .. | .. | ... | .. | .. | 44 | 363 | 1744 | 2015 | 349 | 300 | 280 | 372 | 62 | 19 | .. | 13 | 8 | ... | ... | ... | ... | ... | ... | ... | ... | 5569 |
| May | | 11 | ... | ... | 16 | .. | ... | 6 | .. | 8 | 6 | 192 | 724 | 587 | 838 | 262 | 221 | 150 | 148 | 122 | 182 | 156 | 464 | 224 | 790 | 152 | 199 | 62 | 7 | 45 | ... | . | 5572 |
| June | .. | ... | . | .. | 37 | ... | 10 | 9 | 49 | 111 | 112 | 210 | 368 | 146 | 634 | 377 | 375 | 175 | 289 | 42 | 167 | 169 | 400 | 214 | 449 | 218 | 269 | 57 | 79 | 28 | 12 | ... | 5006 |
| July | 8 | 4 | 3 | 12 | .. | ... | 4 | ... | 18 | 21 | 63 | 229 | 148 | 285 | 403 | 334 | 137 | 122 | 89 | 141 | 187 | 169 | 301 | 405 | 523 | 317 | 272 | 135 | 12 | 26 | 4 | ... | 4372 |
| August | 8 | .. | 5 | 4 | 3 | ... | 10 | 11 | 26 | 25 | 29 | 93 | 270 | 238 | 175 | 108 | 118 | 53 | 62 | 65 | 64 | 106 | 199 | 357 | 548 | 310 | 133 | 34 | 25 | 15 | 1 | .. | 3095 |
| September | 5 | 14 | 8 | 6 | 35 | 34 | 9 | 21 | 27 | 91 | 73 | 212 | 116 | 158 | 70 | 55 | 16 | 53 | 109 | 101 | 47 | 49 | 84 | 100 | 112 | 74 | 95 | 87 | 66 | 53 | 35 | 6 | 2021 |
| October | 106 | 209 | 28 | 91 | 194 | 153 | 78 | 203 | 162 | 251 | 114 | 280 | 119 | 60 | 32 | 5 | 18 | 12 | 14 | 4 | 4 | 6 | .. | . | ... | .. | ... | ... | | .. | 8 | 41 | 2192 |
| November | 412 | 727 | 175 | 233 | 106 | 163 | 100 | 102 | 50 | 107 | 31 | 24 | 3 | 21 | 9 | 5 | 29 | 97 | 24 | 22 | . | 35 | .. | 4 | 53 | ... | 11 | 6 | 5 | 195 | 114 | 404 | 3267 |
| December | 383 | 460 | 306 | 1002 | 450 | 98 | 58 | 232 | 18 | . | . | 1 | 2 | ... | ... | ... | . | .. | .. | ... | | . | ... | . | ... | ... | ... | . | . | .. | 10 | 530 | 3550 |
| Annual | 1640 | 2182 | 1622 | 3178 | 1457 | 736 | 461 | 942 | 936 | 1288 | 621 | 1815 | 3078 | 4345 | 4849 | 1744 | 1415 | 1031 | 1163 | 595 | 676 | 700 | 1461 | 1392 | 2487 | 1123 | 979 | 421 | 280 | 555 | 363 | 1165 | 46700 |

# APPENDIX X.

MADRAS OBSERVATORY.—Number of inches of rain from each point in the year 1918.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 0·45 | 0·52 | 0·30 | 1·32 | 0·65 | 0·14 | ... | 0·31 | 0·24 | 1·05 | ... | .. | ... | . | ... | ... | ... | ... | ... | ... | ... | .. | | 0·14 | 0·06 | 0·46 | ... | 0·45 | ... | 0·26 | 0·84 | 0·86 | ... |
| February | ... | ... | ... | 0·19 | 0·68 | ... | 1·20 | ... | ... | . | 0·11 | ... | ... | ... | ... | ... | ... | ... | ... | | .. | ... | ... | . | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| March | ... | ... | .. | .. | ... | ... | ... | | ... | ... | .. | ... | ... | ... | ... | ... | 0·02 | ... | ... | ... | ... | ... | .. | .. | ... | ... | ... | | | ... | ... | ... | ... |
| April | ... | .. | .. | ... | ... | ... | ... | ... | ... | ... | . | ... | ... | ... | .. | .. | ... | ... | .. | | ... | ... | ... | ... | ... | ... | ... | ... | .. | ... | ... | ... | ... |
| May | .. | ... | ... | .. | .. | ... | ... | .. | . | ... | .. | 0·04 | 0·01 | ... | 0·05 | | 0·08 | 0·02 | 0·51 | 0·86 | 0·73 | ... | 1·17 | 0·03 | 0·47 | 0·66 | ... | 1·17 | ... | .. | ... | ... | ... |
| June | ... | ... | ... | .. | .. | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·05 | ... | 0·82 | 0·05 | 0·43 | . | 0·06 | ... | 0·07 | 0·04 | 0·27 | ... | ... | ... | .. | 0·01 | ... | .. | ... |
| July | .. | | ... | .. | .. | .. | ... | ... | ... | ... | ... | ... | ... | ... | 0·03 | 0·04 | 0·12 | ... | 0·32 | ... | ... | 0·05 | 0·09 | ... | ... | ... | .. | ... | . | . | ... | ... | ... |
| August | ... | ... | 0·01 | ... | ... | .. | 0·49 | ... | 0·07 | .. | 0·02 | 0·01 | 0·11 | 0·15 | 0·07 | 0·22 | ... | ... | 0·81 | ... | ... | ... | 0·01 | 0·11 | 0·13 | ... | ... | 0·32 | ... | 0·40 | | ... | 0·13 |
| September | .. | 0·17 | .. | ... | 0·65 | 0·34 | | ... | . | .. | 0·55 | ... | ... | ... | ... | ... | ... | ... | ... | .. | 0·01 | 0·19 | 0·03 | 0·08 | 0·31 | ... | 0·05 | 0·02 | ... | 0·10 | .. | ... | 0·75 |
| October | 2·50 | 0·34 | | .. | ... | .. | .. | .. | ... | 0·11 | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | .. | ... | ... | .. | ... | 0·11 | 1·21 | 0·07 |
| November | 1·38 | 2·59 | 1·30 | 1·77 | 1·65 | 1·39 | 1·00 | 1·24 | 1·78 | 0·97 | 1·59 | 3·32 | 0·79 | 0·30 | ... | 1·73 | 2·40 | 2·21 | .. | .. | ... | 0·13 | ... | 1·49 | 3·06 | ... | . | ... | .. | 1·38 | 0·23 | 2·09 | 3·39 |
| December | 0·05 | 0·51 | .. | 0·65 | 0·01 | 1·16 | 1·60 | 0·07 | 0·16 | ... | ... | ... | 1·05 | ... | ... | . | ... | ... | ... | ... | ... | ... | .. | ... | ... | .. | ... | . | ... | | ... | 1·39 | 0·02 |
| Annual | 4·38 | 4·13 | 1·61 | 3·93 | 3·64 | 3·03 | 4·29 | 1·62 | 2·25 | 2·13 | 2·27 | 3·37 | 1·96 | 0·45 | 0·20 | 1·99 | 3·44 | 2·28 | 2·07 | 0·86 | 0·80 | 0·37 | 1·37 | 1·89 | 4·30 | 1·12 | 0·05 | 1·96 | ... | 2·15 | 1·18 | 5·55 | 4·36 |

# APPENDIX XI.

MADRAS OBSERVATORY.—Wind, cloud and bright sunshine, 1918.

| Month. | Wind resultant. | | Cloud (0–10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H. | 16 H | 20 H. | Mean. | Average per day. | Greatest number of hours in a day. |
| | MILES. | POINTS. | | | | | | HOURS. | HOURS. |
| January | 154 | N N E. | 5·6 | 5·7 | 4·7 | 4·6 | 5·2 | 5·8 | 9·3 |
| February | 67 | East | 1·6 | 2·2 | 1·9 | 1·5 | 1·8 | 8·9 | 10·1 |
| March | 107 | S E. by S. | 1·5 | 1·9 | 1·1 | 1·2 | 1·5 | 8·9 | 10·8 |
| April | 113 | S.E. by S. | 3·3 | 2·4 | 0·7 | 0·5 | 1·7 | 9·9 | 10·8 |
| May | 90 | South. | 5·1 | 4·2 | 4·9 | 4·4 | 4·6 | 7·1 | 9·9 |
| June | 86 | S.S.W. | 5·1 | 4·3 | 5·8 | 5·8 | 5·2 | 6·0 | 8·8 |
| July | 76 | S. by W. | 4·4 | 4·4 | 5·9 | 5·0 | 5·0 | 5·6 | 8·8 |
| August | 51 | S.W. | 6·3 | 5·7 | 8·1 | 5·3 | 6·4 | 4·6 | 8·6 |
| September | 19 | S. by W. | 6·7 | 6·8 | 6·7 | 4·6 | 6·2 | 4·4 | 10·6 |
| October | 49 | E. by N. | 3·7 | 4·0 | 2·9 | 1·8 | 3·2 | 8·0 | 10·3 |
| November | 73 | N. by E. | 7·8 | 7·9 | 8·3 | 6·4 | 7·6 | 2·5 | 8·9 |
| December | 104 | N.N.E. | 5·3 | 6·2 | 6·0 | 3·5 | 5·3 | 5·1 | 8·2 |
| Annual | 25 | S.E. | 4·7 | 4·6 | 4·7 | 3·7 | 4·5 | 6·4 | ... |

MEAN Monthly and Annual Meteorological Results at the Madras Observatory in 1918.

| Month. | Barometer. | | Dry Bulb Thermometer. | | | | Wet Bulb. | | Tension of Vapour. | Relative Humidity. | Sun Max. in Vac. | Min. on Grass. | Wind. | | | Rain. | | Clear sky. | Bright Sun-shine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reduced to 32°. | Daily Range. | Mean. | Max. | Min. | Range. | Mean. | Min. | By Blandford's Tables. | | | | Daily Velocity. | | Mean Direction. | Amount. | Days. | | |
| | Inches. | Inches. | ° | ° | ° | ° | ° | ° | Inches. | Cents. | ° | ° | Miles. | Points | Points. | Inches. | No. | Cents. | Hours. |
| January | 29·946 | 0·109 | 75·5 | 81·9 | 69·9 | 12·0 | 71·5 | 68·7 | 0·720 | 81 | 140·5 | 67·3 | 190 | 3 | N.E. by N. | 8·05 | 10 | 52 | 178·6 |
| February | 30·003 | ·118 | 75·6 | 85·5 | 66·3 | 19·2 | 70·2 | 65·9 | ·666 | 75 | 150·9 | 63·2 | 93 | 8 | East. | 2·18 | 2 | 18 | 248·7 |
| March | 29·913 | ·124 | 79·3 | 88·1 | 70·9 | 17·2 | 74·4 | 70·6 | ·802 | 78 | 151·7 | 67·6 | 115 | 12 | S.E. | 0·02 | 1 | 15 | 275·3 |
| April | ·823 | ·127 | 83·8 | 93·3 | 76·2 | 17·1 | 78·5 | 75·8 | ·906 | 78 | 152·1 | 73·7 | 186 | 14 | S.S.E. | ... | . | 17 | 297·5 |
| May | ·692 | ·121 | 86·2 | 96·3 | 79·5 | 16·8 | 79·1 | 76·0 | ·897 | 72 | 149·4 | 77·9 | 180 | 17 | S. by W. | 5·80 | 7 | 46 | 219·9 |
| June | ·715 | ·120 | 85·9 | 98·2 | 79·2 | 19·0 | 77·2 | 73·7 | ·815 | 66 | 145·3 | 77·7 | 167 | 18 | S.S.W. | 1·80 | 10 | 52 | 180·0 |
| July | ·744 | ·113 | 86·9 | 99·0 | 80·2 | 18·8 | 76·7 | 73·7 | ·780 | 61 | 149·5 | 78·6 | 141 | 19 | S.W. by S. | 0·65 | 5 | 50 | 175·1 |
| August | ·744 | ·129 | 85·7 | 97·3 | 78·9 | 18·4 | 76·8 | 73·8 | ·835 | 66 | 151·8 | 77·5 | 100 | 19 | S.W. by S. | 3·06 | 12 | 64 | 142·7 |
| September | ·800 | ·138 | 84·3 | 94·5 | 78·1 | 16·4 | 78·5 | 75·2 | ·928 | 77 | 151·4 | 76·4 | 67 | 18 | S.S.W. | 3·25 | 8 | 62 | 132·0 |
| October | ·890 | ·118 | 83·4 | 92·1 | 75·0 | 17·1 | 76·1 | 73·1 | ·803 | 70 | 155·5 | 76·1 | 71 | 8 | East. | 4·34 | 2 | 32 | 250·0 |
| November | ·875 | ·112 | 78·7 | 83·7 | 75·0 | 8·7 | 76·1 | 73·9 | ·862 | 88 | 132·5 | 73·9 | 109 | 5 | N.E. by E. | 39·18 | 23 | 76 | 74·8 |
| December | ·983 | ·106 | 77·0 | 83·1 | 72·0 | 11·1 | 72·6 | 70·4 | ·743 | 80 | 145·3 | 69·9 | 115 | 3 | N.E. by N. | 6·67 | 8 | 53 | 157·0 |
| Annual | 29·844 | 0·120 | 81·9 | 91·1 | 75·1 | 16·0 | 75·6 | 72·6 | 0·813 | 74 | 148·0 | 73·3 | 128 | 12 | S.E. | 75·00 | 88 | 45 | 2331·6 |

EXTREME Monthly Meteorological Records at the Madras Observatory in 1918.

| Month. | Barometer. | | | | | Dry Bulb Thermometer. | | | | Wet Bulb. | | Humidity. | | Sun Th. in Vacuo. | | Grass Therm. | | Wind. | | | | Rain. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | | Lowest. | | Range. | Highest. | | Lowest. | | Lowest. | | Lowest. | | Highest. | | Lowest. | | Highest. | | Lowest. | | Greatest Fall. | |
| | Inches. | Day. | Inches. | Day. | Inches. | ° | Day. | ° | Day. | ° | Day. | Cents. | Day. | ° | Day. | ° | Day. | Miles. | Day. | Miles. | Day. | Inches | Day. |
| January | 30·081 | 30,31 | 29·723 | 17 | 0·358 | 85·0 | 26 | 64·9 | 6 | 64·0 | 6 | 54 | 31 | 152·6 | 3,6 | 61·7 | 6 | **355** | **17** | 95 | 28 | 2·41 | 11 |
| February | **·119** | **10** | ·890 | 26,27 | ·229 | 94·5 | 15 | **60·8** | **15** | **60·3** | **15** | **35** | **15** | 157·1 | 15 | **56·6** | **15** | 189 | 19 | 61 | 24 | 2·07 | 20 |
| March | ·086 | 4 | ·704 | 21 | **·382** | 91·7 | 21 | 66·6 | 12 | 66·6 | 12 | 53 | 17 | 156·2 | 4 | 62·2 | 12 | 202 | 22 | 81 | 9 | 0·02 | 26 |
| April | 29·977 | 10 | ·674 | 7 | ·303 | 99·2 | 27 | 68·5 | 1 | 68·5 | 1 | 49 | 14 | 158·4 | 6 | 64·6 | 1 | 248 | 15 | 112 | 11 | | .. |
| May | ·827 | 1 | **·555** | **24** | ·272 | 102·8 | 15 | 72·7 | 17 | 72·7 | 17 | 39 | 22 | 156·3 | 20 | 72·9 | 16 | 265 | 22 | 96 | 31 | 4·99 | 16 |
| June | ·852 | 3 | ·578 | 29 | 274 | 102·3 | 9 | 72·8 | 15 | 70·9 | 15 | 38 | 8 | 155·2 | 9 | 73·3 | 15 | 213 | 20 | 95 | 30 | 0·82 | 14 |
| July | ·852 | 21 | ·635 | 31 | ·217 | 103·2 | 12 | 75·9 | 2 | 69·2 | 31 | 36 | 5 | 162·4 | 31 | 74·3 | 1 | 235 | 4 | 69 | 28 | 0·32 | 1 |
| August | ·892 | 11 | ·589 | 15 | 303 | **104·1** | **4** | 74·8 | 11 | 70·5 | 4 | 36 | 1,2 | 164·1 | 12 | 71·7 | 11 | 154 | 4 | 43 | 11 | 0·81 | 9 |
| September | ·955 | 19 | ·655 | 3 | ·300 | 101·1 | 7 | 72·8 | 23 | 72·1 | 23 | 39 | 3 | **166·9** | **8** | 71·9 | 23 | 139 | 2 | **16** | **25** | 0·92 | 14 |
| October | ·996 | 28 | ·759 | 30 | 237 | 96·3 | 12 | 68·6 | 26 | 66·4 | 26 | 42 | 12,13,25,26 | 165·5 | 29 | 65·4 | 26 | 209 | 30 | **16** | **10** | 4·23 | 31 |
| November | 30·060 | 30 | ·707 | 19 | 353 | 87·6 | 23 | 70·9 | 11 | 70·6 | 11 | 61 | 19 | 161·6 | 23 | 60·5 | 11 | 317 | 17 | 18 | 13 | **6·33** | **2** |
| December | 097 | 25 | ·801 | 12 | ·296 | 86·0 | 16 | 67·3 | 30 | 63·3 | 10 | 55 | 10 | 156·7 | 4 | 63·5 | 30 | 274 | 11 | 26 | 1 | 2·05 | 1 |

# ANNUAL REPORT

OF THE

# DIRECTOR KODAIKANAL AND MADRAS OBSERVATORIES

FOR 1919

MADRAS:
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1920.

# KODAIKANAL AND MADRAS OBSERVATORIES.

## REPORT FOR THE YEAR 1919.

### CONTENTS.

#### I.—Kodaikanal Observatory.



#### II.—Madras Observatory.

# KODAIKANAL AND MADRAS OBSERVATORIES.

## I.—REPORT OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1919.

*Staff.*—The staff of the Observatory on December 31, 1919, was as follows:—

| | |
|---|---|
| Director ... ... ... ... | J. Evershed, F.R.S. |
| Assistant Director ... ... ... | T. Royds, D.Sc. |
| First Assistant ... ... ... | A. A. Narayana Ayyar, B.A. |
| Magnetic Observer ... ... ... | S. S. Ramaswami Ayyangar, B.A. |
| Second Assistant ... ... ... | Vacant. |
| Third Assistant ... ... ... | S. Balasundaram Ayyar. |
| Weather Observer ... ... ... | L. N. Krishnaswami Ayyar. |
| Writer ... ... ... ... | S. N. Krishna Ayyar. |
| Photographic Assistant ... ... | R. Krishna Ayyar. |
| Magnetic Recorder ... ... ... | S. S. Ranga Achariyar. |

Dr. Royds was released from his work on deputation to the Director of Ordnance Factories, Calcutta, and rejoined the staff at Kodaikanal on August 4th.

The subordinate staff consists of a book-binder, an assistant book-binder, a mechanic, a temporary assistant mechanic, six peons, a boy peon for the dark room, and two lascars.

2. *Buildings and grounds.*—Some repair work to the roof of the spectroheliograph building was partially carried out by the Department of Public Works but left in an unfinished and very unsightly condition. The wire fencing of the observatory compound is in a very unsatisfactory state and repairs were called for in the year 1916, but the Department of Public Works have not yet put the work in hand.

3. *Instruments.*—The 15-inch lens borrowed from the Nizamiah Observatory, Hyderabad, has been in constant use for solar and Venus spectra. The colour curve of this lens has been determined to facilitate accurate focussing for any region of the spectrum. The 8-inch telescope formerly used as a horizontal telescope at Poona Observatory has been mounted on the equatorial of the 20-inch Poona reflector, but had not been brought into use at the close of the year. All of the instruments in use have been kept in good repair and the 18-inch siderostat mirror was resilvered twice during the year. The operation of removing the mirror from its cell, silvering it, and replacing in the cell now takes about two hours only.

4. *Weather conditions.*—With a total rainfall of 65 inches, well distributed through the year, the conditions generally for astronomical work were extremely bad. The mean definition in the north dome at about 8 a.m. was 3·1 on a scale in which 1 is the worst and 5 the best. There were 42 days in which the definition was estimated as 4 or over.

5. *Photoheliograph.*—Photographs on a scale of 8 inches to the sun's diameter were obtained on 333 days using a 6-inch visual achromatic lens and a green colour screen. This combination gives much better contrast in the details of the solar surface, sunspots, etc., than the photo-visual lens without a colour screen.

6. *Spectroheliographs.*—Monochromatic images of the sun's disc in K light were obtained on 329 days, prominence plates on 248 days and H$\alpha$ disc plates on 257 days.

7. *Six-inch Cooke equatorial and spectroscope.*—Work with this instrument has been continued on the same lines as formerly for visual observations of solar phenomena which cannot be readily photographed.

8. *Grating spectrograph.*—This instrument was actively employed throughout the year in photographing solar and arc spectra. A continuous series of sunlight and Fe arc spectra was taken to test the constancy of the Sun—arc displacement. Confining attention to the region 4337–4531 and to lines that are not subject to pole effect in the arc, it was found that some remarkable variations occurred amounting to several thousandths of an angstrom. The variations are of two kinds; a general change affecting all the lines in the region studied, and a change affecting particular lines or groups of lines. In the latter case measures of the distances separating the iron lines in the Sun, and similar measures of the iron lines in the arc, show that the variations are generally due to a slight instability of wave-length in the arc lines. In a few cases there is evidence that the solar lines are not absolutely fixed in their relative positions in the spectrum. Photographs of the iron arc under various conditions also indicate small changes of wave-length, particularly in some plates taken for the purpose of estimating the displacements of lines sensitive to pole effect.

Experiments designed to indicate the cause of these anomalies have all given negative results. It is thought that they may possibly be due to changes in the composition of the samples of impure iron and steel used as pole pieces; or they may have significance in relation to the recent discovery that many elements consist of two or more isotopes, and that differences of wave length of the same order are found in the spectra of the isotopes of lead.

The research is a difficult one being concerned with very small quantities; it is only rendered practicable by the method of superposing a reversed positive on a negative of the spectrum, whereby the displacements are revealed with certainty and estimated rapidly.

9. *Displacements of lines and Einstein's prediction.*—Measures have been made by Mr. Narayana Ayyar of the displacements at the sun's polar limbs of the nitrogen bands near 3883. Fifteen plates of limb spectra and carbon arc, and 10 plates of spectra at the centre of the disc, give the following mean displacements of ten prominent triplet bands :—

| | In angstroms. | In Km/sec. |
|---|---|---|
| North limb ... ... ... ... ... | + 0·0061 | + 0·47 |
| South limb ... ... ... ... ... | + 0·0088 | + 0·68 |
| Centre of disc ... ... ... ... | + 0·0043 | + 0·33 |

These values are very much larger than were obtained by St. John for other groups of lines in the carbon arc spectrum, and taken by themselves they appear favourable to Einstein's theory. The systematic difference between north and south indicates that the displacement may be variable.

Measures of limb spectra in high latitudes and with iron arc comparison also show the difference between north and south, although these were photographed a year later than the carbon arc spectra. The results of this series of plates, taking the mean of ten lines, is as follows :—

| | In angstroms. | In Km/sec. |
|---|---|---|
| North limb ... ... ... ... ... | + 0·0099 | + 0·67 |
| South limb ... ... ... ... ... | + 0·0134 | + 0·91 |
| Centre of disc ... ... ... ... | + 0·0070 | + 0·47 |

All of these results are free from pole effect in the arc and from pressure shift. Our previous researches having shown that pressure does not affect the displacements of the iron lines in the Sun our results for these lines should be considered to be as important a test of the relativity theory as the measures of the nitrogen band lines.

The general result that both band lines and iron lines are displaced at the limb by amounts that, if not in exact agreement with the predicted amount, are of the right sign and order of magnitude appears favourable to Einstein's hypothesis. But the displacement differs for different substances and for different lines in the same substance; and previous work has shown that there is no proportionality between displacement and wave-length. If the displacements are due to a gravitational effect therefore, there must be an unknown modifying influence at work.

The measures of Venus spectra offer the most serious difficulty, for they appear to show that the line displacement only occurs in the light derived from the hemisphere of the Sun facing the Earth.

The hypothesis that motion in the line of sight is the only cause of the line displacement has this great advantage, that all of the anomalies mentioned, including the Venus results, are readily explained. But it involves a controlling action by the Earth which is very difficult to believe.

10. *Venus spectra.*—Between February and June twenty-one measurable plates of Venus and Fe arc were obtained, and ten ordinary daylight control plates. The planet during this period was an evening star and this circumstance gave rise to a serious and unexpected difficulty, for on clear afternoons the heating of a wall by the Sun set up a strain in the masonry of the pier carrying the grating, and after sunset a slight movement of recovery. It is believed that this made the grating rotate through an angle of about 1″ during the exposures on Venus causing a slight drift of the spectra and a broadening of the lines. As this broadening would act unequally on the bright lines of the arc and the absorption lines of Venus measures of the displacements are considered to give very unreliable results.

The cause of the trouble was not discovered and rectified until the middle of April when the wall was completely cut away from all connexion with pier. The February and March plates which should have given decisive results with regard to the wave-length of the lines on the hidden face of the Sun are unfortunately all affected by this source of error. The mean results, Sun—arc, of the plates measured are given in the following table in angstroms :—

| | | | Mean angle ♀—☉—⊕ | More affected lines. | Less affected lines. |
|---|---|---|---|---|---|
| 10 control plates of daylight | | | | + 0·0103 | + 0·0036 |
| 4 Venus plates in | February | ... | 129° | + 0·0163 | + 0·0096 |
| 7 " " | March | .. | 113° | + 0·0097 | − 0·0000 |
| 5 " " | April | ... | 102° | + 0·0065 | − 0·0033 |
| 5 " " | May and June | ... | 67° | + 0·0083 | + 0·0007 |

The anomalous result for the February plates and the relatively high values of the March plates are probably due to the movement of the grating. The April, May and June plates which are free from this defect give values of Sun—arc in accordance with the excellent series obtained in 1918 and referred to in the last Annual Report. They show smaller shifts than the control plates and a tendency to increase as the angle at the Sun diminishes.

A set of eight plates was obtained in November with the planet near western elongation, and the series will be continued until April 1920 when it is hoped that a decisive result may be reached.

11. *Rotation of Venus.*—An inclination of 1° to 2° in the lines of the Venus spectra was found in many of the plates, and this would appear to indicate a direct rotation of the planet in a period of between 20 and 30 hours. Further investigation shows however that this interpretation is not justified. It is probable that a spurious inclination may be produced when the diurnal movement is inclined to the spectrograph slit and irregularities in guiding are mainly in the direction of Right Ascension; for in this case there will be a partial illumination of the slit on one side or

the other according as the image is above or below its mean position on the slit, and this will cause opposite displacements at the two edges of the spectrum. Owing to this uncertainty nothing can yet be said regarding the true rotation period of the planet.

12. *Irregular displacements of spectrum lines on the disc of the Sun.*—Photographs of sections of the Sun's disc have been made in the H$\alpha$ region, and the region studied in the Sun and Fe arc plates. It was found that the irregular displacements discovered in 1918 by superposing a reversed positive on a negative of the spectrum may be observed at the centre of the disc, but up to the present they have not been found very near the limb. It appears therefore that, unlike the displacements in the penumbrae of spots, they may be due to movements normal to the surface, or having a component normal to the surface.

*Summary of sunspot and prominence observations.*

13. *Sunspots.*—The following table shows the monthly numbers of new groups observed at Kodaikanal, and their distribution between the northern and southern hemispheres. The mean daily numbers of spots visible are also given :—

| — | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups .. ... | 24 | 16 | 23 | 18 | 16 | 32 | 18 | 19 | 18 | 16 | 12 | 23 | 235 |
| North ... ... | 11 | 11 | 14 | 8 | 7 | 13 | 7 | 2 | 5 | 7 | 8 | 11 | 104 |
| South ... ... | 13 | 5 | 9 | 10 | 9 | 19 | 11 | 17 | 13 | 9 | 4 | 12 | 131 |
| Daily numbers ... | 3·5 | 4·2 | 4·4 | 3·5 | 4·7 | 6·4 | 4·0 | 4·3 | 3·8 | 3·9 | 2·7 | 3·2 | 4·1 |

Compared with the year 1918 there is a general decrease in spot activity amounting to 29 per cent in the case of new groups. The decrease is much greater for the northern hemisphere than for the southern and there results a considerable preponderance of activity in the south.

The approximate mean latitude of the spots was 10°·4 in the northern and 12°·5 in the southern hemispheres ; a decline of 1°·4 and 2°·1 respectively compared with the figures for 1918.

A remarkable spot group was formed about August 12 on the east limb, on the 14th displacements of the brightly reversed H$\alpha$ line ranging from 6 A towards red to 5 A towards violet were observed at various points in the group. During the September apparition the group had become resolved into two large single spots very near together but on opposite sides of the equator.

The number of bright reversals of the H$\alpha$ line observed in the neighbourhood of spots was 296 whilst the number of displacements of this line recorded near spots was 180 of which no less than 136 were towards red. There were 57 dark reversals of $D_3$ observed.

14. *Prominences.*—There has been a slight decrease in prominence areas and a considerable reduction in numbers compared with the previous year. The mean daily areas derived from the Kodaikanal photographic records are as follows :—

| | North. | South. | Total. |
|---|---|---|---|
| 1919—January to June .. ... | 1·55 | 1·81 | 3·36 |
| July to December ... ... | 1·96 | 2·09 | 4·05 |

The mean daily numbers recorded decreased from 13·6 for the first half of 1919 to 11·3 for the second half; the decrease is mainly in the number of small prominences.

Prominence activity has been considerable in the equatorial regions and as far as latitude 40°; beyond this latitude a rapid decrease is shown, and at 60° the activity practically ceases. Between 60° and the poles very small prominences or transient jets were recorded.

Metallic prominences greatly increased in frequency compared with the year 1918 and prominences showing displaced lines were also more frequently recorded than in the previous year. No displacement exceeding 6 angstroms at H$\alpha$ was seen. There was the usual slight excess of displacements towards red, 54 per cent of the whole number showing motion away from the Earth.

Prominences projected on the disc as absorption markings gave the same latitude distribution as those observed at the limb. The mean areas are about 3 per cent, and numbers 17 per cent less than in 1918; the decrease is therefore mainly in the number of smaller markings as in the prominences at the limb.

The largest prominence photographed during the year attained its greatest development of 12 square minutes of arc on May 29 when a great part of it became detached from the Sun and ascended into space. The angular rotation speed of the prominence, when visible as an absorption marking between May 7th and 13th, was found to be 14°·28 per diem, in agreement with the rotation speed of the reversing layer.

15. *Magnetic observations.*—Continuous magnetograph records are obtained of declination, vertical force, and horizontal force. Absolute observations for dip are made daily excepting Sundays, declination and horizontal force on three days per week alternately. All the records are made over to the Magnetic Survey office, Dehra Dun, and the results are published by the Survey annually.

The declination magnetograph was cleaned early in the year but owing to the excessive dampness of the magnetograph room it is very difficult to keep in good working order and it has been necessary to readjust it several times. The earth inductor No. 45 hitherto in use was sent to the Survey Department for repairs and has been replaced by No. 46 which has proved a less satisfactory instrument.

Twenty-six "great" and 176 "moderate" magnetic storms were registered during the year, a larger number of each designation than were recorded in 1918.

The storm commencing August 11, 12$^h$ 28$^m$ I.S.T. (6$^h$ 58$^m$ G.C.T.) was perhaps the greatest storm recorded since 1909 September 25. A large and very active spot group was developing at the east limb on the 12th.

16. *Workshop construction.*—New iron mountings were made for the large collimator and camera lenses of the 6-inch grating spectrograph. These heavy parts were permanently fixed on the masonry pier by embedding them in asphalt. The collimator is provided with a focussing screw of 1 mm pitch and the camera mounting has a rack and pinion for focussing. The grating mounting was also improved and an iron cup containing mercury attached to it. The bulb of a very sensitive thermometer is immersed in the mercury.

The 6-inch Cooke equatorial telescope was repaired and re-erected. The heavy cast iron sleeve of the declination axis had been broken across near the end on the journey from Kashmir. A satisfactory repair was effected by turning down the broken end to an even cylindrical surface and shrinking a length of steel tube on to it. This was then attached by screws to the larger portion of the broken sleeve.

The old Shelton clock used in the spectroheliograph room for timing all photographs caused much trouble by repeated stoppages. As matters

were not improved by most careful cleaning and oiling, the expedient was tried which had proved so very effective for the driving clock of the large siderostat and for other driving clocks ; this consists in adding one wheel to the clock of slightly larger diameter than the winding drum. The wheel was placed above the clock train and the end of the driving cord, usually attached to a fixed support, is attached instead to the middle of the winding drum and carried over the wheel and down to the weight pulley where it is made continuous with the cord passing directly down from the drum. In this way the driving force of the weight is doubled and it falls at twice its former speed. The advantage gained consists in the reduction of friction at the drum axis due to the balanced pull on the drum. The mass of the weight might be halved or greatly reduced and it would seem that this would be necessary to prevent the weight from unduly controlling the pendulum. However, since this arrangement was added no stoppages have occurred and the clock rate has proved so remarkably uniform that no change in the weight has been made.

This clock is at least 130 years old. It was installed at the Madras Observatory at the foundation of that institution in the year 1791. It has given excellent service throughout its long career, and it is hoped may continue to give accurate time for a further long period.

17. *Madras Observatory.*—The transit instrument and the 8-inch Equatorial telescope were cleaned and completely overhauled in December, and the dome of the Equatorial was made to rotate satisfactorily by removing one of the supporting wheels ; this was in order to put more weight on the driving wheel and give it some resilience. This method had been found quite successful in the case of another troublesome dome at Kodaikanal. Tests of the solar definition and the definition of stars in daylight were made with the 8-inch. As in previous trials the seeing was found to be extraordinarily good near midday and it is considered that these observations have, with others, demonstrated the immense advantage for solar work of the proximity of the sea or other extended water surface.

18. *Time.*—The error of the standard clock is usually determined by reference to the 16-hour signal from the Madras Observatory. This is rendered possible by the courtesy of the Telegraph Department which permits the Madras wire to be joined through to this observatory. The signal is received with accuracy on most days and all failures are at once reported to the Postmaster-General, Madras.

19. *Meteorology.*—Eye observations are made at $8^h$, $10^h$ and $16^h$ local mean time as in former years. The Richard thermograph (wet and dry bulb) and barograph, the Beckley anemograph, and the sunshine recorder also continue in use. Cloud observations with the nephoscope are made three times daily.

*Pressure.*—The average pressure for the year was 0·006 inch above normal. The mean pressure was above normal from January to April and August to October and below normal in the remaining months, the greatest excess being 0·029 inch in February and the greatest defect 0·038 in November. The highest pressure recorded was 22·972 inches on February 5 and the lowest 22·643 inches on July 30.

*Temperature.*—The monthly mean temperature was above normal in every month, the mean for the year being 2° in excess. The minimum grass temperature for the year was 27°·1 on January 17.

*Humidity.*—The mean humidity for the year was normal, viz., 74 cents. The driest day in the year was March 10, when the humidity was 7 cents.

*Rainfall.*—The total annual fall was 65 inches or 5·5 inches above normal. The wettest month was September when 11·68 inches fell on 17 days and the driest was February with 0·33 inches on one day only.

*Wind.*—The wind direction was not far from normal in all months except May when the mean was S. by W. instead of N.N.E. The mean daily movement was 268 miles, the normal being 306 miles. The mean velocity was in defect in all months except June.

*Transparency of the atmosphere.*—The transparency of the lower atmosphere as judged by the visibility of the Nilgiris, about 100 miles distant, was very near the average.

*Cloud and sunshine.*—The percentage of cloud was normal in January and October, below normal in February and March and above normal in the remaining months. July and September were the cloudiest months. The total number of hours of bright sunshine was 2365 which is 17 per cent above normal.

20. *Seismology.*—The Milne horizontal pendulum recorded ninety earthquakes as against 127 during last year. Details of the records are given in Appendix 1.

21. *Library.* One hundred and seven volumes were bound during the year.

22. *Publications.*—Bulletin Nos. 60 and 61 dealing with the half-yearly distribution of the prominences were issued during the year but only a limited number of copies were distributed outside India.

In addition the Director has contributed a paper on "The Spectrum of Nova Aquilae" to the "Monthly Notices of the Royal Astronomical Society", Vol. 59, page 468; and notes on the following subjects to the "Observatory":—

| | Vol. | page. |
|---|---|---|
| 1. The displacements of the solar lines reflected by Venus ... ... | 42 | 51 |
| 2. Calcium clouds in the milky way ... ... ... ... ... | 42 | 85 |
| 3. The Pulsation theory of Cepheid Variables ... ... ... | 42 | 124 |
| 4. The Moon in Daylight ... ... ... ... ... ... | 42 | 339 |

23. *General.*—The staff of the observatory has worked well during the year. Mr. Narayana Ayyar has obtained very satisfactory results in the exacting work of measuring innumerable Sun and arc spectra by the positive on negative method, and Mr. Krishna Ayyar has shown great energy and perseverance in the numerous photographic processes now required, especially in the sensitizing of plates for the H*a* spectroheliograms.

KODAIKANAL,
*29th January* 1920.

J. EVERSHED,
*Director, Kodaikanal and Madras Observatories.*

## II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1919.

*Staff.*—The following was the staff of the Madras Observatory during the year 1919 :—

| | |
|---|---|
| Deputy Director ... ... ... ... | R. Ll. Jones (January 1 to April 4).<br>James Angus (April 5 to May 3).<br>S. Solomon Pillai (May 4 to June 30).<br>Edward B. Ross (July 1 to December 17).<br>Edward Barnes (December 18 to 31). |
| Computer ... ... ... ... ... | S. Solomon Pillai. |
| First Assistant ... ... ... ... | C. Chengalvaraya Mudaliyar. |
| Second Assistant ... ... ... ... | P. Jayaram Mudaliyar. |

Mr. R. Ll. Jones left Madras on combined leave preparatory to retirement. Mr. Solomon Pillai was absent on privilege leave from 1st to 31st October 1919.

2. *Time service.*—The time gun at Fort St. George failed on 11 occasions out of 731 giving a percentage of success of 98·5. Of these failures one was due to a fault at the Observatory. The gun was fired at 8 a.m. and 11 a.m. instead of at 12 noon on November 11 on account of the anniversary of the armistice. The time ball at the Harbour failed altogether on one day. On four other days it failed at 1 p.m. but dropped correctly at 2 p.m. The 4 p.m. roll of signals was sent to the Central Telegraph office on every day and was received there correctly.

3. *Meteorological observations.*—Eye observations were made four times a day and the record of self-registering instruments maintained as usual. Extra observations were taken for storm warning purposes and telegrams sent to Calcutta on 51 occasions and to Simla on one occasion.

4. *Buildings.*—The usual annual repairs to the office and quarters were carried out during the year.

5. *Instruments.*—The following is a list of the instruments at the Observatory on 31st December 1919 :—

(*a*) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton and Simms.
Sidereal clock—Haswall.
Do. Dent, No. 1408.
Do. S. Riefler, No. 61.
Mean Time clock—J. H. Agar Baugh, No. 105.
Do. with galvanometer—Shepherd & Sons.
Meridian circle—Troughton and Simms.
Portable transit instrument—Dollond.
Tape chronograph—R. Fuess.
Relay for use with the chronograph—Siemens.

(*b*) *Meteorological.*

Richard's barograph—No. 10, L. Casella.
Do. thermograph—No. 29637, L. Casella.
Peander's self-recording rain-gauge—No. 116, Lawrence and Mayo.
Beckley's anemograph—Adie.
Sunshine recorder—No. 149, L. Casella.
Nephoscope—Mons Jules Daboseq and Ph. Pellin.
Barometer, Fortin's—No. 1771, L. Casella.
Do. do. No. 725, L. Casella (spare).
Do. do. No. 1420, L. Casella (spare).
Dry bulb thermometer—No. 94221, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).

Wet bulb thermometer—No. 94219, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Dry maximum thermometer—No. 8581, Negretti and Zambra.
Dry minimum do. No. 69017, L. Casella.
Wet do. do. No. 91753, Negretti and Zambra.
Sun maximum do. No. 127618, Negretti and Zambra.
Grass minimum do. No. 3377, Negretti and Zambra.
Rain-gauge (8″ diameter)—No. 1042, Negretti and Zambra.
Measure glass for above.
Rain-gauge (5″ diameter).
Measure glass for above.
Stop watch—No. A-3.

The level error of the Transit Circle at the beginning of the year was + $0^s \cdot 13$. Very little change occurred in the first two months. In the middle of March it began to change in the usual manner and reached its maximum negative value — $4^s \cdot 31$ in the middle of October. In the course of a few days of heavy rain at the beginning of November it went through a rapid change in the reverse direction.

6. *Weather summary.*—The following is a summary of the meteorological conditions at Madras during 1919 :—

*Pressure.*—The mean monthly pressure was normal in January, April and August, was below normal in June, November and December and above in the remaining months, the greatest excess being 0·075 inch in July and the greatest defect 0·065 inch in November. The highest pressure recorded was 30·130 inches on the 6th and 15th January.

*Temperature.*—The mean temperature of the air was normal in July and September and above normal during the remaining months. The maximum shade temperature was below normal in July and September, normal in March, October and December and above normal during the other months. The highest temperature recorded was 108°·2 F. on May 21. The minimum in shade was above normal in all other months except September when it was below normal and in March, October and December when it was about normal. The lowest temperature recorded was 64°·5 F. on January 2. The highest sun maximum was 164°·5 F. on September 12, and the lowest on grass 61°·2 F. on January 2.

*Humidity.*—The percentage of humidity was normal in March, below normal in May, June and August and above during the remaining months. The driest day in the year was June 8.

*Wind.*—The wind velocity was in defect throughout the year. The wind direction was normal from March to May and in December.

*Cloud.*—The amount of cloud was above normal in February, June, November and December. The sky was less cloudy than usual during the other months.

*Sunshine.*—The percentage of sunshine was above normal in July and September and below in all the other months. The total number of hours of bright sunshine during the year was 2206·3.

*Rainfall.*—The rainfall was above the average in March, June, July, September and December and below in the remaining months. The greatest excess was 2·29 inches in July and the greatest deficiency 2·09 inches in May. The total fall for the year was 50·78 inches on 90 days against an average of 49·02 inches. The monsoon rainfall from October 15 to the end of the year was 27·24 inches. The heaviest rainfall on one day was 3·18 inches on September 28.

THE OBSERVATORY, MADRAS,
31*st January* 1920.

EDWARD BARNES,
*Offg. Deputy Director, Madras Observatory.*

# APPENDIX I.

## STATION—KODAIKANAL OBSERVATORY.

### SEISMIC RECORDS.

$\phi = 10° 13' 50''$ $\lambda = 77° 28' 00''$ $h = 2343$ metres. *Subsoil*—Rock.

*Apparatus*—Milne's Horizontal Pendulum Seismograph.

| 1919. | $T_o$ | $\frac{T}{T_o^2}$ | 1919. | $T_o$ | $\frac{T}{T_o^2}$ |
|---|---|---|---|---|---|
| January ... .. ... | 17·3 | 2·9 | July ... .. ... | 18·0 | 2·7 |
| February ... .. ... | 17·4 | 3·0 | August .. ... ... | 18·0 | 2·7 |
| March ... ... ... | 17·5 | 3·0 | September ... ... | 17·8 | 2·8 |
| April ... ... ... | 17·6 | 2·6 | October ... ... . | 17·7 | 2·8 |
| May ... ... . | 17·6 | 2·8 | November .. ... .. | 17·9 | 2·6 |
| June ... ... ... | 17·6 | 2·6 | December ... ... ... | 18·0 | 2·6 |

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period. (Sec.). | Amplitude ($\mu$). An. | Ae. | Az. | Distance $\Delta$ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1919. | | | | | | | | | | |
| 1 | January 1 ... | eP | 1 | 42 | 18 | ... | ... | ... | ... | .. | There was another maximum (amplitude 2·0 mm) at 3h 23m·8 and a fresh series of comparatively large oscillations commenced then and lasted for about an hour. |
| | | iL | 1 | 49 | 30 | ... | ... | .. | ... | ... | |
| | | M | 1 | 50 | 00 | ... | ... | 220 | ... | ... | |
| | | F | 5 | 47 | 24 | ... | ... | ... | .. | ... | |
| 2 | 6 ... | eP | 22 | 47 | 24 | ... | .. | . | . | ... | |
| | | eL | 23 | 20 | 18 | ... | ... | ... | ... | . | |
| | | M | 23 | 28 | 00 | ... | ... | 60 | | . | |
| | | F | 23 | 39 | 42 | ... | | .. | .. | ... | |
| 3 | 18 ... | eP | 6 | 03 | 18 | ... | . | ... | .. | ... | |
| | | eL | 6 | 08 | 30 | ... | ... | . | . | .. | |
| | | M | 6 | 09 | 30 | . | ... | 240 | .. | ... | |
| | | F | 6 | 28 | 42 | ... | ... | .. | . | .. | |
| 4 | February 12 ... | eP | 13 | 26 | 24 | . | .. | . | | ... | Widening of line. |
| | | F | 13 | 43 | 48 | . | .. | | ... | ... | |
| 5 | 17 ... | eP | 18 | 30 | 30 | ... | .. | . | ... | . | Widening of line. |
| | | F | 18 | 41 | 18 | ... | ... | | ... | .. | |
| 6 | 18 ... | eP | 16 | 39 | 06 | ... | ... | . | | .. | Widening of line. |
| | | F | 16 | 42 | 30 | .. | | ... | ... | ... | |
| 7 | 22 .. | eP | 5 | 04 | 54 | ... | ... | .. | ... | .. | Widening of line. |
| | | F | 5 | 10 | 00 | ... | . | | . | .. | |
| 8 | March 2 ... | eP | 4 | 41 | 48 | . | ... | ... | ... | ... | |
| | | eL | 4 | 44 | 18 | . | . | | ... | | |
| | | M | 4 | 59 | 42 | ... | .. | 100 | ... | .. | |
| | | F | 5 | 45 | 18 | ... | . | . | ... | ... | |
| 9 | 2 ... | eP | 12 | 07 | 24 | | ... | .. | ... | ... | Several widenings of line. |
| | | F | 12 | 58 | 42 | ... | .. | . | ... | | |
| 10 | 2 ... | eP | 13 | 00 | 42 | ... | ... | ... | ... | ... | |
| | | eL | 13 | 08 | 12 | ... | ... | .. | ... | .. | |
| | | M | 13 | 16 | 06 | ... | ... | 70 | ... | ... | |
| | | F | 13 | 58 | 42 | .. | . | .. | .. | ... | |
| 11 | 9 ... | eP | 3 | 57 | 54 | ... | ... | . | .. | .. | |
| | | eL | 4 | 34 | 12 | ... | ... | ... | .. | ... | |
| | | M | 4 | 50 | 30 | | . | 100 | ... | | |
| | | F | 5 | 05 | 48 | ... | ... | ... | . | ... | Record faint as light was burning low. Light was put out at 5h 9m for marking the time on the sheet. |
| 12 | 16 . | eP | 7 | 48 | 24 | ... | .. | . | ... | .. | |
| | | eL | 7 | 52 | 12 | ... | ... | ... | ... | ... | |
| | | M | 8 | 08 | 12 | ... | ... | 60 | ... | ... | |
| | | F | 8 | 24 | 18 | .. | ... | ... | .. | ... | |

| No. | Date. | | Phase | Time G.M.T. H. | M. | S. | Period. (Sec.). | Amplitude ($\mu$) AN. | AE | AZ | Distance $\Delta$ (Km.). | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1919. | | | | | | | | | | | |
| 13 | March | 21 ... | eP | 18 | 07 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 18 | 11 | 54 | ... | ... | . | ... | ... | |
| 14 | April | 2 ... | eP | 0 | 41 | 42 | ... | | ... | ... | ... | |
| | | | eL | 0 | 45 | 54 | ... | ... | ... | ... | .. | |
| | | | M | 0 | 54 | 54 | . | ... | 180 | ... | ... | |
| | | | F | 1 | 10 | 12 | ... | ... | ... | ... | | |
| 15 | | 7 ... | eP | 10 | 10 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 10 | 12 | 06 | ... | ... | ... | ... | ... | |
| 16 | | 10 ... | eP | 3 | 39 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 3 | 41 | 48 | ... | ... | ... | ... | .. | |
| 17 | | 16 ... | P | | .. | | ... | ... | .. | ... | ... | No P.Ts. Light was removed from 3h 59m to 4h 3m for changing sheet. P.Ts. probably occurred during this interval. |
| | | | eL | 4 | 13 | 48 | .. | ... | ... | .. | ... | |
| | | | M | 4 | 15 | 54 | ... | ... | 70 | ... | ... | |
| | | | F | 4 | 23 | 06 | ... | ... | ... | ... | ... | |
| 18 | | 16 ... | eP | 17 | 13 | 48 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 17 | 17 | 42 | ... | ... | ... | ... | ... | |
| 19 | | 17 ... | eP | 11 | 40 | 48 | ... | ... | ... | ... | ... | |
| | | | eL | 12 | 14 | 06 | ... | ... | .. | ... | ... | |
| | | | M | 12 | 32 | 12 | .. | ... | 650 | ... | ... | |
| | | | F | 13 | 59 | 42 | ... | .. | ... | ... | ... | |
| 20 | | 17 ... | eP | 21 | 32 | 00 | ... | ... | ... | ... | ... | |
| | | | eL | 22 | 23 | 30 | ... | ... | .. | ... | ... | |
| | | | M | 22 | 31 | 36 | ... | ... | 80 | ... | ... | |
| | | | F | 23 | 14 | 06 | ... | ... | ... | ... | ... | |
| 21 | | 21 ... | eP | 12 | 21 | 06 | .. | ... | ... | . | ... | |
| | | | iL | 12 | 28 | 48 | .. | ... | ... | ... | ... | |
| | | | M | 12 | 35 | 00 | ... | ... | 110 | ... | ... | |
| | | | F | 12 | 54 | 36 | ... | ... | ... | ... | ... | |
| 22 | | 23 ... | eP | 8 | 08 | 36 | ... | ... | ... | ... | .. | Widening of line. |
| | | | F | 8 | 20 | 00 | .. | .. | ... | .. | .. | |
| 23 | | 24 ... | eP | 17 | 29 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 17 | 37 | 42 | ... | ... | ... | ... | .. | |
| 24 | | 27 ... | eP | 0 | 36 | 12 | ... | ... | ... | .. | ... | |
| | | | eL | 0 | 48 | 06 | ... | ... | ... | ... | ... | |
| | | | M | 0 | 50 | 24 | ... | ... | 110 | ... | ... | |
| | | | F | 1 | 16 | 00 | ... | ... | ... | ... | ... | |
| 25 | | 30 ... | eP | 7 | 36 | 54 | ... | ... | ... | ... | ... | |
| | | | eL | 7 | 43 | 00 | ... | ... | .. | ... | ... | |
| | | | $M_1$ | 8 | 22 | 48 | ... | ... | 1400 | ... | ... | |
| | | | $M_2$ | 8 | 26 | 54 | ... | ... | 1550 | ... | ... | |
| | | | $M_3$ | 8 | 31 | 48 | | ... | 1480 | ... | ... | |
| | | | $M_4$ | 8 | 34 | 36 | ... | ... | 1450 | | ... | |
| | | | $M_5$ | 8 | 38 | 42 | . | .. | 1470 | ... | ... | |
| | | | $M_6$ | 8 | 46 | 24 | ... | ... | 1350 | ... | ... | |
| | | | $M_7$ | 8 | 49 | 30 | ... | ... | 1300 | ... | ... | |
| | | | $M_8$ | 8 | 53 | 36 | .. | ... | 1250 | ... | ... | |
| | | | F | 12 | 09 | 00 | ... | ... | ... | ... | ... | |
| 26 | May | 1 ... | eP | 4 | 06 | 24 | ... | ... | ... | ... | .. | Widening of line. |
| | | | F | 4 | 08 | 00 | ... | ... | ... | ... | ... | |
| 27 | | 1 ... | eP | 5 | 21 | 00 | ... | .. | ... | ... | ... | |
| | | | eL | 5 | 29 | 12 | ... | ... | | ... | ... | |
| | | | M | 5 | 33 | 18 | ... | ... | 220 | ... | ... | |
| | | | F | 6 | 09 | 30 | ... | ... | | .. | ... | |
| 28 | | 2 ... | eP | 3 | 07 | 48 | ... | ... | ... | ... | ... | |
| | | | eL | 3 | 14 | 18 | ... | ... | | ... | ... | |
| | | | M | 3 | 17 | 24 | ... | ... | 50 | ... | ... | |
| | | | F | 4 | 13 | 00 ? | .. | ... | .. | ... | ... | Instrument examined at 4h 13m. |
| 29 | | 6 ... | eP | 6 | 31 | 18 | ... | ... | ... | ... | ... | Widening of line. In continuation of hour mark. |
| | | | F | 6 | 33 | 18 | | ... | . . | ... | ... | |
| 30 | | 6 ... | eP | 19 | 30 | 12 | ... | ... | .. | ... | ... | P.T. merged in hour mark. |
| | | | eL | 19 | 55 | 06 | .. | ... | | ... | ... | |
| | | | M | 20 | 28 | 30 | ... | ... | 450 | ... | .. | |
| | | | F | 23 | 17 | 24 | ... | .. | ... | ... | ... | |
| 31 | | 7 ... | eP | 5 | 44 | 24 | ... | .. | ... | .. | ... | |
| | | | eL | 6 | 02 | 48 | ... | ... | ... | ... | ... | |
| | | | M | 6 | 07 | 12 | ... | ... | 50 | ... | ... | |
| | | | F | 6 | 24 | 24 | ... | ... | ... | .. | ... | |
| 32 | | 11 ... | eP | 5 | 35 | 24 | | ... | ... | ... | ... | Widening of line. |
| | | | F | 5 | 38 | 42 | ... | ... | ... | ... | ... | |

| No. | Date. | | Phase. | Time G.M.T. H. | M. | S. | Period. (Sec.). | Amplitude ($u$). An. | Ae. | Az. | Distance. △ (Km.) | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1919. | | | | | | | | | | | |
| 33 | May | 22 ... | eP | 12 | 46 | 18 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 13 | 06 | 48 | ... | ... | ... | | ... | |
| 34 | | 23 ... | P | | ... | | ... | ... | ... | ... | ... | No P.Ts. |
| | | | iL | 6 | 21 | 18 | ... | ... | ... | ... | ... | |
| | | | M | 6 | 25 | 36 | ... | ... | 200 | ... | ... | |
| | | | F | 6 | 55 | 48 | ... | ... | ... | ... | ... | |
| 35 | | 27 ... | eP | 18 | 15 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 18 | 24 | 54 | ... | ... | ... | ... | ... | |
| 36 | | 29 ... | eP | 11 | 11 | 54 | ... | ... | ... | ... | ... | |
| | | | eL | 11 | 19 | 00 | ... | ... | ... | ... | ... | |
| | | | M | 11 | 24 | 36 | ... | ... | 50 | ... | ... | |
| | | | F | 11 | 34 | 06 | ... | ... | ... | | ... | |
| 37 | June | 1 ... | eP | 7 | 05 | 48 | ... | ... | ... | ... | ... | |
| | | | eL | 7 | 07 | 18 | ... | | ... | ... | ... | |
| | | | M | 7 | 08 | 18 | ... | ... | 50 | ... | ... | |
| | | | F | 7 | 16 | 30 | ... | ... | ... | ... | ... | |
| 38 | | 1 ... | eP | 15 | 06 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 15 | 07 | 48 | ... | ... | ... | ... | ... | |
| 39 | | 7 ... | eP | 14 | 19 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 14 | 20 | 42 | ... | | ... | ... | ... | |
| 40 | | 7 ... | eP | 14 | 59 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 15 | 00 | 24 | ... | ... | ... | ... | ... | |
| 41 | | 7 ... | i | 15 | 08 | 00 | ... | ... | 30 | ... | ... | Earthquake of intensity IV heard and felt. Line displaced towards east. |
| 42 | | 10 ... | eP | 21 | 14 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 21 | 16 | 24 | ... | ... | ... | ... | ... | |
| 43 | | 13 ... | eP | 12 | 20 | 48 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 12 | 23 | 48 | ... | ... | ... | ... | ... | |
| 44 | | 13 ... | eP | 18 | 48 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 18 | 51 | 12 | ... | ... | ... | ... | ... | |
| 45 | | 20 ... | eP | 14 | 02 | 48 | | ... | ... | ... | ... | Widening of line. |
| | | | F | 14 | 04 | 00 | ... | ... | ... | ... | ... | |
| 46 | | 20 ... | eP | 17 | 40 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 17 | 41 | 42 | ... | ... | ... | ... | ... | |
| 47 | | 20 ... | eP | 18 | 17 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 18 | 19 | 00 | ... | ... | ... | ... | ... | |
| 48 | | 26 ... | eP | 17 | 39 | 54 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 17 | 46 | 48 | ... | ... | ... | ... | ... | |
| 49 | | 28 ... | eP | 5 | 13 | 54 | ... | ... | ... | ... | ... | |
| | | | eL | 5 | 15 | 54 | ... | ... | ... | ... | ... | |
| | | | M | 5 | 18 | 00 | ... | ... | 30 | ... | ... | |
| | | | F | 5 | 27 | 42 | ... | ... | ... | ... | ... | |
| 50 | | 28 ... | eP | 10 | 44 | 48 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 10 | 46 | 18 | ... | ... | ... | ... | ... | |
| 51 | | 30 ... | eP | 0 | 43 | 48 | ... | ... | ... | ... | ... | |
| | | | eL | 0 | 54 | 36 | ... | ... | ... | ... | ... | |
| | | | M | 0 | 56 | 42 | ... | ... | 50 | ... | ... | |
| | | | F | 1 | 17 | 12 | ... | | ... | ... | ... | |
| 52 | | 30 ... | eP | 5 | 53 | 48 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 5 | 55 | 42 | ... | ... | ... | ... | ... | |
| 53 | | 30 ... | eP | 7 | 40 | 48 | ... | ... | ... | ... | ... | |
| | | | eL | 7 | 47 | 54 | ... | ... | ... | ... | ... | |
| | | | M | 7 | 52 | 36 | ... | ... | 450 | ... | ... | |
| | | | F | 8 | 20 | 18 | ... | ... | ... | ... | ... | |
| | | | | | | | | | | | | Air tremors during high wind were frequent during the month. |
| 54 | July | 4 ... | eP | 13 | 01 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 13 | 03 | 36 | ... | ... | ... | ... | ... | |
| 55 | | 4 ... | eP | 13 | 51 | 36 | ... | ... | | ... | ... | |
| | | | eL | 13 | 52 | 54 | ... | ... | ... | ... | ... | |
| | | | M | 13 | 55 | 48 | ... | ... | 100 | ... | ... | |
| | | | F | 14 | 03 | 00 | ... | ... | ... | ... | ... | |
| 56 | | 8 ... | eP | 21 | 14 | 36 | ... | ... | ... | ... | ... | |
| | | | iL | 21 | 29 | 00 | | ... | | ... | ... | |
| | | | M | 21 | 34 | 06 | ... | ... | 1000 | ... | ... | |
| | | | F | | ? | | ... | ... | ... | ... | ... | The boom touched the box at 21h 36m·7 and did not oscillate afterwards. Hence the end is not recorded. |
| 57 | | 14 ... | eP | 14 | 36 | 12 | ... | ... | ... | ... | ... | |
| | | | eL | 14 | 39 | 18 | ... | ... | | ... | ... | |
| | | | M | 14 | 40 | 18 | ... | ... | 50 | ... | ... | |
| | | | F | 14 | 51 | 06 | ... | ... | ... | ... | ... | |

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period. (Sec.). | Amplitude (u). An. | Ae. | Az. | Distance △ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1919. | | | | | | | | | | |
| 58 | July 24 ... | eP | 2 | 14 | 18 | ... | ... | ... | ... | ... | |
| | | iL | 2 | 18 | 24 | ... | ... | ... | ... | ... | |
| | | M | 2 | 19 | 24 | ... | ... | 680 | ... | ... | |
| | | F | | ? | | ... | ... | .. | .. | ... | Instrument examined at 2h 45m. Air tremors due to high wind (35 miles an hour) were frequently recorded from 27th to 31st. |
| 59 | August 3 .. | eP | 3 | 32 | 30 | ... | ... | .. | ... | | |
| | | F | 3 | 36 | 06 | | .. | | ... | ... | Widening of line. |
| 60 | 14 ... | eP | 17 | 46 | 24 | ... | ... | ... | ... | ... | |
| | | F | 17 | 53 | 06 | | ... | .. | ... | .. | * Widening of line. |
| 61 | 25 ... | eP | 20 | 17 | 00 | .. | ... | .. | ... | ... | |
| | | F | 20 | 21 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| 62 | 27 ... | eP | 5 | 58 | 42 | ... | ... | | ... | ... | |
| | | F | 6 | 14 | 06 | ... | . | ... | ... | ... | Widening of line. |
| 63 | 28 ... | eP | 20 | 02 | 48 | ... | ... | . | | ... | |
| | | F | 20 | 07 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| 64 | 29 ... | eP | 5 | 55 | 30 | ... | ... | ... | ... | ... | |
| | | eL | 6 | 11 | 18 | ... | ... | ... | .. | ... | |
| | | M | 6 | 18 | 30 | ... | ... | 320 | ... | .. | |
| | | F | 7 | 25 | 24 | .. | ... | ... | ... | ... | |
| 65 | 29 .. | eP | 8 | 40 | 42 | ... | ... | .. | ... | ... | Widening of line. |
| | | F | 8 | 42 | 48 | ... | ... | ... | ... | .. | |
| 66 | 31 ... | eP | 17 | 38 | 12 | . | .. | ... | .. | ... | |
| | | iL | 17 | 44 | 06 | ... | ... | ... | .. | . | |
| | | $M_1$ | 17 | 47 | 54 | ... | ... | 230 | ... | ... | |
| | | $M_2$ | 18 | 22 | 36 | ... | ... | 180 | .. | . | |
| | | F | 18 | 55 | 36 | ... | ... | . | ... | ... | |
| 67 | September 1 ... | eP | 20 | 34 | 36 | ... | ... | .. | ... | ... | Widening of line. |
| | | F | 20 | 37 | 06 | ... | ... | ... | ... | ... | |
| 68 | 12 ... | eP | 7 | 03 | 18 | .. | ... | ... | ... | ... | |
| | | eL | 7 | 11 | 36 | ... | ... | ... | ... | ... | |
| | | M | 7 | 14 | 06 | ... | ... | 40 | ... | ... | |
| | | F | 7 | 19 | 12 | ... | ... | ... | ... | ... | |
| 69 | 13 .. | P | | ... | | ... | ... | ... | ... | ... | No P.Ts. |
| | | iL | 12 | 50 | 42 | ... | ... | ... | ... | ... | |
| | | M | 12 | 51 | 00 | ... | ... | 50 | ... | ... | |
| | | F | 13 | 06 | 24 | ... | ... | ... | ... | . | |
| 70 | 13 ... | eP | 13 | 42 | 18 | ... | ... | ... | ... | ... | |
| | | eL | 13 | 43 | 48 | ... | ... | ... | ... | ... | |
| | | M | 13 | 47 | 24 | ... | ... | 60 | ... | ... | |
| | | F | 14 | 02 | 48 | ... | .. | ... | .. | ... | |
| 71 | 26 ... | eP | 9 | 15 | 24 | ... | ... | ... | ... | .. | |
| | | eL | 9 | 30 | 12 | ... | ... | ... | . | ... | |
| | | M | 9 | 32 | 48 | ... | ... | 50 | ... | ... | |
| | | F | 9 | 49 | 00 | ... | ... | ... | .. | .. | |
| 72 | 26 ... | eP | 19 | 49 | 42 | ... | ... | .. | .. | .. | |
| | | iL | 19 | 54 | 24 | ... | ... | | ... | ... | |
| | | M | 20 | 14 | 24 | ... | ... | 150 | ... | ... | |
| | | F | 20 | 50 | 48 | ... | .. | ... | .. | . | |
| 73 | 26 ... | eP | 21 | 55 | 54 | ... | ... | | ... | . | Widening of line. |
| | | F | 21 | 58 | 30 | ... | ... | ... | ... | ... | |
| 74 | 26 ... | eP | 22 | 07 | 12 | ... | ... | .. | ... | .. | Widening of line. |
| | | F | 22 | 11 | 30 | ... | ... | ... | ... | ... | |
| 75 | 27 ... | eP | 23 | 19 | 30 | ... | ... | ... | | .. | Widening of line. |
| | | F | 23 | 26 | 42 | ... | ... | ... | ... | ... | |
| 76 | October 3 ... | eP | 10 | 37 | 24 | ... | ... | ... | ... | ... | |
| | | iL | 10 | 40 | 30 | ... | .. | ... | ... | ... | |
| | | M | 10 | 41 | 18 | ... | ... | 70 | ... | ... | |
| | | F | 11 | 00 | 48 | ... | ... | ... | ... | ... | |
| 77 | 4 ... | eP | 6 | 25 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 6 | 26 | 06 | . | ... | .. | ... | .. | |
| 78 | 4 ... | P | | ... | | ... | ... | | ... | ... | No P.Ts. |
| | | iL | 17 | 55 | 12 | ... | ... | | | ... | |
| | | M | 17 | 57 | 42 | .. | ... | 210 | ... | ... | |
| | | F | 18 | 20 | 48 | ... | ... | .. | .. | .. | |
| 79 | 4 ... | eP | 19 | 44 | 00 | ... | ... | ... | ... | .. | Widening of line. |
| | | F | 19 | 53 | 00 | ... | ... | .. | ... | ... | |
| 80 | 9 ... | P | | ... | | ... | ... | ... | ... | ... | No P.Ts. |
| | | eL | 7 | 06 | 06 | | ... | ... | .. | ... | |
| | | M | 7 | 09 | 42 | ... | ... | 60 | ... | ... | |
| | | F | 7 | 18 | 24 | ... | ... | . | ... | .. | |
| 81 | 10 .. | eP | 2 | 10 | 18 | ... | ... | .. | ... | ... | Widening of line. |
| | | F | 2 | 22 | 30 | ... | ... | | | ... | |
| 82 | 12 ... | eP | 21 | 54 | 30 | ... | ... | ... | .. | . | |
| | | eL | 21 | 59 | 12 | ... | ... | ... | ... | ... | |
| | | M | 22 | 07 | 00 | ... | ... | 260 | .. | ... | |
| | | F | 22 | 43 | 48 | ... | ... | ... | ... | ... | |

* No record from 18th 4h to 19th 4h 14m as the lamp did not burn.

| No. | Date. | | Phase. | Time G.M.T. | | | Period. (Sec.). | Amplitude (μ). | | | Distance Δ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | An. | Ae. | Az. | | |
| | 1919. | | | H | M | S | | | | | | |
| 83 | October 24 | ... | eP | 20 | 47 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 20 | 50 | 00 | | ... | ... | ... | ... | |
| 84 | 31 | ... | eP | 16 | 18 | 42 | ... | ... | | ... | ... | |
| | | | eL | 16 | 22 | 18 | ... | ... | ... | ... | ... | |
| | | | M | 16 | 25 | 24 | ... | ... | 70 | ... | ... | |
| | | | F | 16 | 43 | 48 | ... | ... | ... | ... | ... | |
| 85 | November 15 | ... | eP | 6 | 20 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 6 | 24 | 00 | | ... | ... | ... | ... | |
| 86 | 18 | ... | eP | 22 | 19 | 12 | ... | ... | ... | ... | ... | |
| | | | eL | 22 | 27 | 00 | | ... | ... | ... | ... | |
| | | | M | 22 | 35 | 18 | ... | ... | 90 | ... | ... | |
| | | | F | 22 | 55 | 36 | ... | ... | ... | ... | ... | |
| 87 | 20 | ... | eP | 14 | 34 | 48 | ... | ... | ... | ... | ... | |
| | | | eL | 15 | 06 | 48 | ... | ... | ... | ... | ... | |
| | | | M | 15 | 08 | 48 | ... | | 40 | ... | ... | |
| | | | F | 15 | 25 | 30 | ... | ... | ... | ... | ... | |
| 88 | December 14 | ... | eP | 2 | 06 | 54 | | ... | | ... | ... | |
| | | | eL | 2 | 10 | 42 | ... | | ... | ... | ... | |
| | | | M | 2 | 16 | 12 | | ... | 60 | ... | ... | |
| | | | F | 2 | 35 | 06 | ... | ... | ... | ... | ... | |
| 89 | 20 | ... | eP | 19 | 58 | 42 | ... | ... | ... | ... | ... | |
| | | | eL | 20 | 02 | 48 | | ... | ... | ... | ... | |
| | | | M | 20 | 08 | 00 | ... | ... | 50 | ... | ... | |
| | | | F | 20 | 25 | 24 | ... | ... | | ... | ... | |
| 90 | 20 | ... | eP | 20 | 45 | 54 | | ... | ... | ... | ... | |
| | | | iL | 20 | 52 | 00 | ... | ... | ... | ... | ... | |
| | | | M | 21 | 05 | 54 | | ... | 150 | ... | ... | |
| | | | F | 22 | 23 | 18 | ... | ... | ... | ... | ... | |

# APPENDIX II.

Latitude 10° 13′ 50″ N. Height of Barometer cistern above mean sea level 7688 feet.

Longitude 5h 9m 52s E.

MEAN Monthly and Annual Meteorological Results at the Kodaikanal Observatory in 1919.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily Range. | Dry Bulb Thermometer. Mean. | Dry Bulb Thermometer. Max. | Dry Bulb Thermometer. Min. | Dry Bulb Thermometer. Range. | Wet Bulb. Mean. | Wet Bulb. Min. | Tension of Vapour. By Simpson's Tables. | Relative Humidity. By Simpson's Tables. | Sun Max. in Vac. | Min. on Grass. | Wind. Daily Velocity | Wind. | Wind. Mean Direction. | Rain. Amount. | Rain. Days. | Clear Sky. | Bright Sunshine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Inches. | ° | ° | ° | ° | | | Inches. | Cents. | | | Miles. | Points | Points. | Inches. | No. | Cents. | Hours. |
| January | 22·872 | 0·062 | 56·0 | 64·2 | 47·8 | 16·4 | 49·3 | 43·1 | 0·293 | 67 | 122·2 | 35·3 | 241 | 6 | E.N.E. | 5·24 | 6 | 63 | 259·6 |
| February | ·882 | ·069 | 57·6 | 67·4 | 47·9 | 19·5 | 48·3 | 41·0 | ·253 | 54 | 124·5 | 39·2 | 252 | 4 | N.E. | 0·33 | 1 | 69 | 260·2 |
| March | ·882 | ·066 | 59·4 | 69·1 | 49·8 | 19·3 | 49·1 | 43·1 | ·242 | 50 | 133·1 | 36·9 | 279 | 5 | N.E. by E. | 1·01 | 3 | 79 | 313·9 |
| April | ·847 | ·065 | 62·4 | 70·9 | 53·9 | 17·0 | 54·5 | 48·9 | ·353 | 64 | 134·4 | 45·1 | 234 | 6 | E.N.E. | 4·87 | 7 | 48 | 250·6 |
| May | ·807 | ·064 | 61·5 | 69·2 | 53·7 | 15·5 | 55·9 | 51·2 | ·398 | 76 | 132·5 | 47·2 | 215 | 17 | S by E. | 7·02 | 10 | 42 | 215·1 |
| June | ·753 | ·053 | 59·4 | 65·1 | 53·6 | 11·5 | 54·8 | 50·8 | ·395 | 82 | 122·3 | 49·6 | 408 | 24 | W. | 2·53 | 7 | 22 | 157·7 |
| July | ·751 | ·056 | 58·1 | 63·7 | 52·5 | 11·2 | 54·4 | 50·5 | ·397 | 85 | 122·2 | 48·2 | 345 | 24 | W. | 4·48 | 12 | 18 | 138·0 |
| August | ·789 | ·057 | 58·7 | 64·8 | 52·5 | 12·3 | 54·3 | 49·6 | ·390 | 82 | 124·7 | 47·8 | 309 | 24 | W. | 6·77 | 10 | 24 | 153·9 |
| September | ·796 | ·070 | 58·0 | 63·9 | 52·1 | 11·8 | 55·0 | 50·7 | ·411 | 87 | 120·7 | 47·2 | 184 | 19 | S.W. by S. | 11·68 | 17 | 18 | 118·0 |
| October | ·827 | ·065 | 58·1 | 64·4 | 51·7 | 12·7 | 54·3 | 49·9 | ·393 | 84 | 121·7 | 46·6 | 219 | 28 | N.W. | 8·44 | 15 | 32 | 164·6 |
| November | ·791 | ·067 | 55·5 | 61·5 | 49·5 | 12·0 | 51·6 | 47·3 | ·354 | 82 | 114·6 | 43·8 | 273 | 30 | N N W. | 8·30 | 13 | 32 | 145·9 |
| December | ·827 | ·062 | 55·2 | 61·9 | 48·5 | 13·4 | 50·9 | 45·3 | ·339 | 79 | 116·3 | 40·9 | 261 | 7 | E by N. | 4·39 | 11 | 40 | 187·4 |
| Annual | 22·819 | 0·062 | 58·3 | 65·5 | 51·2 | 14·4 | 52·7 | 47·6 | 0·351 | 74 | 124·1 | 44·0 | 268 | 26 | W.N.W. | 65·06 | 112 | 41 | 2364·9 |

EXTREME Monthly Meteorological Records at the Kodaikanal Observatory in 1919.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry Bulb Thermometer. Highest. | | Dry Bulb Thermometer. Lowest. | | Wet Bulb Lowest. | | Humidity. Lowest. | | Sun Th. in Vacuo. Highest. | | Grass Therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest Fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Day | Inches | Day | Inches. | ° | Day. | ° | Day. | ° | Day. | Cents. | Day | ° | Day. | ° | Day. | Miles. | Day. | Miles. | Day | Inches. | Day. |
| January | 22·958 | 6 | 22·773 | 17 | 0·185 | 69·6 | 1 | **42·4** | **17** | **33·2** | **3** | 9 | 3 | 133·7 | 20 | **27·1** | **17** | 436 | 5 | 146 | 29 | 2·06 | 28 |
| February | **972** | **5** | ·786 | 22 | ·186 | 70·9 | 28 | 43·9 | 23 | 33·6 | 24 | 14 | 3 | 136·7 | 5 | 34·1 | 5 | 317 | 12 | 174 | 19 | 0·31 | 21 |
| March | ·952 | 20 | ·825 | 9 & 27 | ·127 | 72·6 | 30 | 42·8 | 10 | 33·5 | 10 | **7** | **10** | 144·4 | 19 | 29·0 | 10 | 473 | 26 | 122 | 20 | 0·41 | 17 |
| April | ·939 | 22 | ·753 | 13 | ·186 | **75·7** | **6** | 50·3 | 6 | 43·0 | 4 | 21 | 3 | 148·9 | 16 | 38·8 | 1 | 367 | 3 | 160 | 9 | 1·18 | 20 |
| May | ·879 | 6 | ·715 | 28 & 29 | ·164 | 72·4 | 2 | 51·8 | 19 | 46·1 | 31 | 35 | 31 | 145·7 | 17 | 42·3 | 2 | 394 | 31 | 134 | 26 | 1·92 | 7 |
| June | ·832 | 23 | ·646 | 5 | ·186 | 69·3 | 1 | 51·8 | 19 | 46·6 | 9 | 52 | 16 | 134·0 | 10 | 46·1 | 9 | 590 | 7 | 227 | 4 | 0·45 | 24 |
| July | ·834 | 14 | **·643** | **30** | ·191 | 68·2 | 24 | 51·2 | 3 & 4 | 42·6 | 29 | 55 | 9 | 144·5 | 22 | 44·0 | 13 & 21 | **800** | **28 & 29** | 110 | 16 | 0·83 | 20 |
| August | ·866 | 20 | ·694 | 1 | ·172 | 68·8 | 17 | 49·2 | 25 | 40·6 | 16 | 46 | 15 | **149·5** | **17** | 41·1 | 16 | 500 | 1 | 133 | 28 | 1·68 | 29 |
| September | ·906 | 11 | ·708 | 24 | ·198 | 66·5 | 27 | 49·2 | 2 | 44·9 | 2 | 59 | 1 | 138·9 | 15 | 37·7 | 2 | 335 | 9 | **92** | **24** | 2·17 | 19 |
| October | ·894 | 1 | ·770 | 18 | ·124 | 68·0 | 2 | 48·3 | 8 | 37·8 | 7 | 35 | 7 | 140·3 | 3 | 38·5 | 8 | 381 | 5 & 27 | 111 | 17 | 1·81 | 30 |
| November | ·900 | 24 | ·665 | 2 | ·235 | 67·2 | 27 | 44·6 | 17 | 36·4 | 17 | 26 | 15 | 136·1 | 22 | 32·9 | 17 | 578 | 3 | 109 | 21 | **2·31** | **30** |
| December | ·926 | 19 | ·742 | 14 | ·184 | 67·5 | 13 | 42·8 | 11 | 33·4 | 21 | 22 | 21 | 128·0 | 15 | 27·9 | 11 | 535 | 6 | 159 | 14 | 0·78 | 2 |

# APPENDIX III.

KODAIKANAL mean hourly wind velocity for the year 1919.

| Month. | Hours. | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| January | 11 | 11 | 11 | 11 | 9 | 9 | 9 | 10 | 11 | 12 | 12 | 12 | 12 | 11 | 9 | 9 | 8 | 7 | 8 | 9 | 9 | 10 | 10 | 11 |
| February | 12 | 12 | 12 | 12 | 12 | 10 | 12 | 12 | 12 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 7 | 8 | 9 | 10 | 11 | 11 |
| March | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 14 | 14 | 18 | 17 | 16 | 14 | 12 | 11 | 10 | 8 | 7 | 7 | 7 | 7 | 8 | 11 | 12 |
| April | 10 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 10 | 11 | 12 | 11 | 11 | 11 | 11 | 10 | 10 | 9 | 9 | 10 | 9 | 9 | 9 | 9 |
| May | 10 | 9 | 10 | 10 | 10 | 10 | 10 | 9 | 8 | 9 | 10 | 10 | 9 | 9 | 9 | 8 | 8 | 8 | 7 | 8 | 8 | 9 | 9 | 9 |
| June | 20 | 18 | 19 | 18 | 19 | 18 | 17 | 17 | 16 | 14 | 14 | 16 | 15 | 13 | 15 | 16 | 16 | 17 | 18 | 18 | 18 | 18 | 19 | 19 |
| July | 15 | 15 | 15 | 16 | 14 | 14 | 14 | 15 | 14 | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 15 |
| August | 16 | 15 | 15 | 15 | 14 | 14 | 13 | 13 | 12 | 12 | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 12 | 13 | 14 | 14 | 14 | 15 | 16 |
| September | 8 | 7 | 9 | 8 | 8 | 8 | 8 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 7 | 8 |
| October | 10 | 11 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 9 | 9 | 8 | 8 | 9 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 9 |
| November | 12 | 13 | 12 | 12 | 12 | 12 | 12 | 12 | 11 | 11 | 11 | 11 | 11 | 10 | 9 | 9 | 9 | 10 | 11 | 13 | 12 | 12 | 12 | 12 |
| December | 11 | 12 | 11 | 11 | 11 | 11 | 11 | 11 | 10 | 12 | 13 | 12 | 11 | 11 | 10 | 9 | 8 | 9 | 10 | 10 | 11 | 12 | 12 | 12 |
| Mean | 12 | 12 | 12 | 12 | 12 | 11 | 11 | 12 | 11 | 12 | 12 | 12 | 11 | 11 | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 12 | 12 |

## APPENDIX IV.

KODAIKANAL mean hourly bright sunshine for the year 1919.

| Month. | Hours. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6–7 | 7–8 | 8–9 | 9–10 | 10–11 | 11–12 | 12–13 | 13–14 | 14–15 | 15–16 | 16–17 | 17–18 |
| January | 0·23 | 0·80 | 0·81 | 0·88 | 0·92 | 0·89 | 0·84 | 0·82 | 0·79 | 0·69 | 0·61 | 0·72 |
| February | ·51 | ·95 | ·93 | ·94 | ·97 | ·97 | ·92 | ·79 | ·72 | ·73 | ·60 | ·25 |
| March | ·63 | ·88 | ·92 | ·96 | ·97 | ·95 | ·91 | ·90 | ·86 | ·82 | ·80 | ·53 |
| April | ·44 | ·82 | ·88 | ·91 | ·94 | ·89 | ·84 | ·75 | ·64 | 63 | ·41 | ·20 |
| May | ·29 | ·68 | ·81 | ·88 | ·85 | ·78 | ·71 | ·61 | ·46 | ·39 | ·35 | ·13 |
| June | ·12 | ·40 | ·51 | ·66 | ·70 | ·61 | ·59 | ·53 | ·39 | ·35 | ·30 | ·08 |
| July | ·13 | ·47 | ·57 | ·56 | ·56 | ·49 | ·46 | ·37 | ·33 | ·28 | ·17 | ·06 |
| August | ·14 | ·53 | ·73 | ·64 | ·59 | ·61 | ·52 | ·38 | ·34 | ·30 | ·13 | ·04 |
| September | ·14 | ·42 | ·51 | ·62 | ·56 | ·45 | ·36 | ·39 | ·23 | 14 | ·08 | ·04 |
| October | ·28 | ·47 | ·55 | ·69 | ·65 | ·62 | ·48 | ·45 | ·36 | ·38 | ·22 | ·05 |
| November | ·18 | ·50 | ·57 | ·58 | ·57 | ·50 | ·48 | ·44 | ·38 | ·37 | 22 | ·06 |
| December | ·09 | ·53 | ·64 | ·68 | ·77 | ·68 | ·61 | ·55 | ·55 | ·48 | ·40 | ·03 |
| Mean | 0·26 | 0·62 | 0·70 | 0·75 | 0·75 | 0·70 | 0·64 | 0·58 | 0·50 | 0·46 | 0·36 | 0·18 |

## APPENDIX V.

NUMBER of days in each month on which the Nilgiris were visible in 1919.

| Month. | Very clear. | Visible. | Just visible. | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January | ... | 8 | 2 | 2 | 12 |
| February | ... | 14 | 2 | 1 | 17 |
| March | 2 | 8 | ... | 2 | 12 |
| April | ... | ... | ... | 1 | 1 |
| May | ... | 8 | ... | 1 | 9 |
| June | 1 | 4 | ... | ... | 5 |
| July | ... | 11 | ... | ... | 11 |
| August | ... | 8 | 4 | ... | 12 |
| September | 2 | 9 | 1 | 1 | 13 |
| October | 1 | 11 | ... | ... | 12 |
| November | 3 | 10 | ... | ... | 13 |
| December | ... | 11 | 1 | 1 | 13 |
| Total | 9 | 102 | 10 | 9 | 130 |

# APPENDIX VI.

MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1919.

| Abnormals of | January. | February. | March. | April. | May. | June. | July. | August. | September | October. | November. | December | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure ... ... ... | + 0·001 | + 0·017 | + 0·036 | + 0·003 | + 0·012 | − 0·034 | + 0·075 | − 0·004 | + 0·018 | + 0·016 | − 0·065 | − 0·028 | − 0·003 |
| Temperature of air ... ... ... ... ... | + 3·2 | + 3·0 | + 0·5 | + 1·3 | + 1·6 | + 1·0 | − 0·2 | + 2·7 | + 0·2 | + 1·1 | + 2·0 | + 1·7 | + 1·5 |
| Do. of evaporation ... ... .. | + 4·2 | + 2·8 | + 0·6 | + 1·5 | + 0·8 | + 0·4 | + 1·5 | + 1·3 | + 2·2 | + 1·9 | + 3·1 | + 2·3 | + 1·4 |
| Percentage of humidity ... ... ... | + 5 | + 1 | normal | + 1 | − 2 | − 8 | + 8 | − 4 | + 8 | + 4 | + 5 | + 3 | + 2 |
| Greatest solar heat in vacuo ... ... ... | + 12·2 | + 14·7 | + 12·6 | + 13·5 | + 14·5 | + 4·2 | + 4·5 | + 10·0 | + 9·5 | + 12·9 | + 7·8 | + 5·3 | + 10·1 |
| Maximum in shade ... ... ... ... | + 0·7 | + 1·1 | − 0·3 | + 0·7 | + 1·5 | + 0·5 | − 1·3 | + 2·8 | − 1·4 | + 0·2 | + 1·2 | − 0·2 | + 0·4 |
| Minimum in shade .. ... ... ... ... | + 4·6 | + 3·4 | − 0·1 | + 1·5 | + 0·5 | + 0·5 | + 0·3 | + 1·7 | − 0·2 | + 1·1 | + 2·1 | + 2·5 | + 1·4 |
| Do. on grass ... ... ... | + 6·1 | + 4·6 | + 1·0 | + 2·2 | + 1·1 | + 1·2 | + 0·3 | + 1·6 | + 0·3 | + 1·9 | + 3·2 | + 4·1 | + 2·4 |
| Rainfall in inches .. ... ... ... ... | − 0·52 | − 0·28 | + 1·57 | − 0·62 | − 2·09 | + 0·38 | + 2·29 | − 1·44 | + 2·09 | − 0·20 | − 0·38 | + 0·96 | ... |
| Do. since January 1st ... ... ... | ... | − 0·80 | + 0·77 | + 0·15 | − 1·94 | − 1·56 | + 0·73 | − 0·71 | + 1·38 | + 1·18 | + 0·80 | + 1·76 | + 1·76 |
| General direction of wind .. ... . ... | 1 point E | 2 points S. | normal | normal | normal | 2 points W. | 1 point S. | 2 points W. | 4 points E. | 4 points N. | 2 points E. | normal | normal |
| Daily velocity in miles ... ... ... ... | − 57 | − 31 | − 35 | − 18 | − 71 | − 45 | − 52 | − 28 | − 72 | − 60 | − 79 | − 42 | − 49 |
| Percentage of cloudy sky ... ... ... ... | − 1 | + 4 | − 11 | − 1 | − 5 | + 7 | − 8 | − 1 | − 13 | − 2 | + 2 | + 12 | − 2 |
| Do. of bright sunshine ... ... ... | − 4·4 | − 5·7 | − 3·7 | − 0·1 | − 3·4 | − 12·3 | + 4·9 | − 1·9 | + 6·5 | − 8·7 | − 5·9 | − 12·3 | − 8·4 |

+ means *above* normal ; − means *below* normal.

## APPENDIX VII.

ABSTRACT of the Mean Meteorological Condition of Madras in the year 1919 compared with the average of past years.

| Mean values of | 1919. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure ... ... ... ... | 29·861 | 0·003 below. | 29·864 |
| Temperature of air ... ... ... ... ... ... | 82·6 | 1·5 above. | 81·1 |
| Do. of evaporation ... ... ... ... ... | 75·9 | 1·4 above. | 74·5 |
| Percentage of humidity ... ... ... ... ... ... | 74 | 2 above. | 72 |
| Greatest solar heat in *vacuo* ... ... ... ... ... | 149·8 | 10·1 ,, | 139·7 |
| Maximum in shade ... ... ... ... ... ... | 91·2 | 0·4 ,, | 90·8 |
| Minimum in shade ... ... ... ... ... ... | 76·1 | 1·4 ,, | 74·7 |
| Do. on grass ... ... ... ... ... ... | 74·3 | 2·4 ,, | 71·9 |
| Rainfall since January 1st on 90 days ... ... ... ... | 50·78 | 1·76 ,, | 49·02 |
| General direction of wind ... ... ... ... ... | S.E. | Nil. | S.E. |
| Daily velocity in miles ... ... ... ... ... ... | 122 | 49 below. | 171 |
| Percentage of cloudy sky ... ... ... ... ... | 47 | 2 ,, | 49 |
| Do. of bright sunshine ... .. ... ... ... | 50·0 | 8·4 ,, | 58·4 |

DURATION and quantity of the wind from different points.

| From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North. | 195 | 1054 | East. | 108 | 518 | South. | 146 | 759 | West | 235 | 1893 |
| N. by E. | 334 | 1845 | E. by S. | 301 | 1274 | S. by W. | 218 | 1103 | W. by N. | 170 | 1160 |
| N.N.E. | 229 | 1454 | E.S.E. | 256 | 1205 | S.S.W. | 156 | 797 | W.N.W. | 142 | 880 |
| N.E. by N. | 281 | 1969 | S.E by E. | 717 | 3543 | S.W. by S. | 188 | 1032 | N.W. by W. | 105 | 724 |
| N.E. | 155 | 977 | S.E. | 557 | 3276 | S.W. | 217 | 1159 | N.W. | 58 | 332 |
| N.E. by E. | 133 | 827 | S.E. by S. | 901 | 5907 | S.W. by W. | 215 | 1241 | N.W. by N. | 56 | 200 |
| E.N.E. | 76 | 431 | S.S.E. | 318 | 2395 | W.S.W. | 199 | 1334 | N.N.W. | 37 | 196 |
| E by N. | 144 | 691 | S. by E. | 290 | 1678 | W. by S. | 310 | 2074 | N. by W. | 139 | 653 |

There were 1174 calm hours during the year. The resultant corresponding to the above numbers is represented by a S.E. by S. wind, blowing with a uniform daily velocity of 29 miles.

# APPENDIX VIII.

MADRAS OBSERVATORY.—Number of hours of wind from each point in the year 1919.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 13 | 27 | 29 | 104 | 69 | 48 | 22 | 36 | 27 | 40 | 22 | 83 | ... | ... | ... | ... | ... | ... | .. | ... | ... | ... | ... | .. | ... | .. | ... | ... | ... | ... | ... | ... | 224 |
| February | ... | ... | ... | .. | ... | 2 | ... | 21 | 37 | 104 | 141 | 190 | 18 | 19 | 3 | 3 | ... | 2 | 1 | 1 | 3 | 3 | ... | ... | .. | ... | ... | ... | ... | .. | ... | ... | 124 |
| March | 2 | 1 | ... | ... | .. | 1 | ... | 15 | 2 | 1 | 15 | 175 | 196 | 185 | 19 | 34 | 7 | 10 | 7 | 2 | 2 | 2 | 2 | 2 | .. | 1 | ... | 2 | 1 | 1 | 1 | 4 | 54 |
| April | ... | ... | ... | ... | .. | ... | .. | ... | ... | ... | .. | 78 | 93 | 308 | 109 | 29 | 13 | 18 | 9 | 10 | 1 | 1 | ... | 6 | ... | ... | 2 | ... | ... | ... | 1 | 5 | 37 |
| May | 1 | 3 | .. | 1 | 1 | | 2 | 7 | 5 | 11 | 7 | 48 | 132 | 186 | 40 | 43 | 29 | 26 | 20 | 10 | 27 | 25 | 12 | 12 | 20 | 19 | 16 | 12 | 1 | 4 | 2 | 3 | 19 |
| June | 14 | 8 | 1 | 5 | 4 | 3 | 2 | 5 | 3 | 11 | 9 | 10 | 14 | 19 | 23 | 27 | 9 | 22 | 39 | 31 | 53 | 42 | 59 | 98 | 66 | 48 | 42 | 25 | 7 | 5 | 1 | 4 | 11 |
| July | 1 | 1 | ... | 1 | 1 | . | 1 | 2 | 2 | 6 | 12 | 32 | 18 | 84 | 53 | 39 | 12 | 33 | 24 | 48 | 53 | 39 | 58 | 67 | 54 | 23 | 18 | 15 | 23 | 8 | 4 | ... | 12 |
| August | 1 | ... | 2 | 1 | 1 | 1 | ... | 1 | ... | 2 | 9 | 23 | 13 | 11 | 10 | 37 | 30 | 40 | 33 | 50 | 44 | 63 | 45 | 87 | 70 | 43 | 41 | 39 | 18 | 11 | .. | 1 | 17 |
| September | 1 | 2 | 1 | 3 | 4 | 16 | 3 | 5 | 5 | 44 | 22 | 51 | 62 | 72 | 42 | 40 | 9 | 35 | 19 | 24 | 20 | 22 | 11 | 18 | 7 | 14 | 2 | 3 | ... | 4 | 4 | 2 | 153 |
| October | 12 | 53 | 23 | 35 | 17 | 19 | 10 | 18 | 4 | 19 | 16 | 18 | 3 | 1 | 9 | 26 | 37 | 28 | 3 | 12 | 13 | 16 | 10 | 20 | 18 | 20 | 3 | 4 | 2 | 17 | 9 | 29 | 220 |
| November | 64 | 56 | 49 | 29 | 18 | 23 | 16 | 30 | 23 | 24 | 3 | 9 | 8 | 16 | 10 | 12 | ... | 4 | 1 | ... | 1 | 2 | 2 | ... | ... | 2 | 18 | 5 | 6 | 6 | 15 | 59 | 209 |
| December | 86 | 183 | 124 | 102 | 40 | 20 | 20 | 4 | ... | 39 | ... | ... | ... | . | ... | .. | ... | ... | . | ... | ... | ... | ... | ... | ... | . | ... | ... | .. | .. | .. | 32 | 94 |
| Annual total | 195 | 334 | 229 | 281 | 155 | 133 | 76 | 144 | 108 | 301 | 256 | 717 | 557 | 901 | 318 | 290 | 146 | 218 | 156 | 188 | 217 | 215 | 199 | 310 | 235 | 170 | 142 | 105 | 58 | 56 | 37 | 139 | 1174 |

# APPENDIX IX.

MADRAS OBSERVATORY.—Number of miles of wind from each point in the year 1919.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 94 | 141 | 136 | 648 | 346 | 310 | 118 | 165 | 151 | 146 | 74 | 353 | | .. | ... | ... | ... | ... | ... | ... | .. | ... | ... | . | . | .. | . | ... | ... | ... | | . | 2682 |
| February | ... | ... | ... | ... | .. | 8 | ... | 91 | 152 | 471 | 628 | 909 | 106 | 86 | 19 | 24 | .. | 13 | 8 | 5 | 13 | 13 | ... | ... | . | . | ... | ... | . | . | | . | 2546 |
| March | 9 | 12 | | ... | ... | 5 | ... | 48 | 26 | 4 | 55 | 803 | 974 | 1057 | 168 | 185 | 48 | 66 | 42 | 19 | 12 | 12 | 16 | 7 | ... | 4 | ... | 7 | 4 | 4 | 7 | 35 | 3629 |
| April | | | ... | .. | .. | .. | ... | | ... | .. | .. | 387 | 605 | 2397 | 984 | 270 | 112 | 168 | 86 | 103 | 9 | 7 | ... | 14 | ... | . | 20 | .. | ... | .. | 2 | 25 | 5189 |
| May | 8 | 18 | ... | 11 | 8 | .. | 13 | 58 | 41 | 87 | 52 | 315 | 945 | 1259 | 318 | 230 | 150 | 133 | 117 | 73 | 129 | 154 | 85 | 86 | 162 | 146 | 88 | 81 | 9 | 22 | 19 | 14 | 4831 |
| June | 64 | 38 | 14 | 32 | 30 | 11 | 20 | 40 | 18 | 57 | 61 | 81 | 97 | 135 | 188 | 205 | 70 | 118 | 184 | 180 | 286 | 338 | 468 | 807 | 705 | 420 | 284 | 175 | 59 | 21 | 8 | 23 | 5237 |
| July | 9 | 5 | ... | 5 | 6 | ... | 5 | 16 | 15 | 44 | 66 | 161 | 132 | 480 | 374 | 250 | 72 | 153 | 117 | 280 | 366 | 244 | 380 | 388 | 412 | 139 | 127 | 104 | 132 | 29 | 14 | ... | 4525 |
| August | 6 | .. | 10 | 10 | 6 | 8 | . | 10 | .. | 9 | 69 | 172 | 92 | 56 | 79 | 252 | 168 | 217 | 157 | 198 | 230 | 323 | 293 | 606 | 516 | 302 | 288 | 315 | 97 | 45 | .. | 5 | 4539 |
| September | 7 | 10 | 9 | 6 | 14 | 35 | 20 | 29 | 17 | 159 | 106 | 243 | 254 | 379 | 211 | 171 | 44 | 123 | 64 | 125 | 78 | 87 | 60 | 62 | 52 | 62 | 13 | 21 | | 26 | 27 | 8 | 2522 |
| October | 29 | 243 | 108 | 141 | 86 | 58 | 37 | 74 | 6 | 61 | 75 | 57 | 8 | 5 | 35 | 68 | 95 | 105 | 18 | 49 | 34 | 61 | 27 | 104 | 46 | 82 | 13 | 5 | 6 | 42 | 53 | 109 | 1940 |
| November | 268 | 339 | 332 | 174 | 153 | 190 | 85 | 148 | 92 | 119 | 19 | 62 | 63 | 53 | 19 | 23 | .. | 7 | 4 | | 2 | 2 | 5 | . | ... | 5 | 47 | 16 | 25 | 11 | 66 | 248 | 2577 |
| December | 560 | 1039 | 845 | 942 | 328 | 202 | 133 | 12 | ... | 117 | .. | ... | ... | ... | ... | ... | .. | ... | ... | ... | ... | ... | ... | .. | ... | ... | ... | . | ... | .. | .. | 186 | 4364 |
| Annual | 1054 | 1845 | 1454 | 1969 | 977 | 827 | 431 | 691 | 518 | 1274 | 1205 | 3543 | 3276 | 5907 | 2395 | 1678 | 759 | 1103 | 797 | 1032 | 1159 | 1241 | 1334 | 2074 | 1893 | 1160 | 880 | 724 | 332 | 200 | 196 | 653 | 44581 |

# APPENDIX X.

MADRAS OBSERVATORY.—Number of inches of rain from each point in the year 1919.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 0·01 | 0·06 | ... | ... | ... | ... | ... | ... | ... | ... | 0·30 | | ... | | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| February | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| March | 0·01 | 0·03 | ... | ... | ... | 0·78 | ... | | 0·77 | ... | ... | 0·24 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | 0·13 | ... |
| April | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | ... | ... |
| May | ... | 0·02 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | 0·01 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| June | 0·75 | 0·05 | ... | 0·61 | ... | ... | ... | 0·02 | ... | ... | 0·08 | ... | ... | ... | ... | ... | 0·08 | 0·01 | 0·33 | 0·06 | 0·24 | ... | ... | 0·10 | 0·06 | 0·01 | ... | 0·09 | ... | ... | ... | ... | ... |
| July | ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·08 | 0·23 | 0·04 | 0·02 | 0·35 | 0·53 | 1·69 | 0·75 | 1·16 | 0·15 | 0·68 | 0·15 | ... | 0·12 | 0·06 | 0·06 | ... | 0·04 | ... | 0·05 |
| August | ... | ... | ... | ... | 0·01 | ... | ... | ... | ... | ... | ... | 0·04 | 0·56 | ... | ... | 0·38 | 0·11 | 0·01 | 0·03 | 0·04 | 0·08 | 0·02 | 0·13 | 0·88 | 0·45 | 0·11 | 0·03 | ... | 0·18 | 0·06 | ... | ... | ... |
| September | ... | ... | ... | 0·04 | 0·23 | ... | ... | ... | 0·12 | ... | 0·06 | 0·05 | 1·54 | 0·06 | ... | 0·03 | ... | 0·47 | 1·13 | 0·47 | 0·48 | 0·76 | 0·29 | 0·16 | ... | ... | ... | ... | ... | 0·44 | 0·14 | ... | 0·31 |
| October | 0·27 | 1·70 | 0·10 | 1·33 | 0·06 | 0·12 | 0·05 | 0·15 | ... | ... | 1·03 | ... | 1·02 | ... | ... | 0·26 | 0·12 | 0·59 | ... | ... | 0·04 | ... | ... | ... | 0·01 | 0·35 | ... | 0·42 | ... | 0·10 | 0·10 | 1·20 | 1·78 |
| November | 2·38 | 1·27 | 0·41 | 0·50 | 1·38 | 1·37 | 0·24 | ... | 0·94 | 0·22 | 0·09 | 0·63 | 0·01 | ... | ... | 0·14 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1·10 | ... | ... | ... | 0·56 | 1·59 |
| December | 0·41 | 0·68 | 0·94 | 0·79 | 0·96 | 0·56 | 0·39 | ... | ... | 0·45 | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·86 | 0·20 |
| Annual | 3·83 | 3·81 | 1·45 | 3·27 | 2·64 | 2·83 | 0·68 | 0·17 | 1·83 | 0·67 | 1·56 | 0·96 | 3·13 | 0·14 | 0·23 | 0·85 | 0·33 | 1·44 | 2·02 | 2·26 | 1·59 | 1·94 | 0·57 | 1·82 | 0·67 | 0·47 | 0·15 | 1·67 | 0·24 | 0·60 | 0·28 | 2·75 | 3·93 |

## APPENDIX XI.

MADRAS OBSERVATORY.—Wind, cloud and bright sunshine, 1919.

| Month. | Wind resultant. | | Cloud (0—10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H. | 16 H. | 20 H. | Mean. | Average per day. | Greatest number of hours in a day. |
| | MILES. | POINTS. | | | | | | HOURS. | HOURS. |
| January | 71 | N.E. by E. | 3·5 | 4·9 | 3·5 | 2·4 | 3·6 | 7·3 | 8·8 |
| February | 85 | E.S.E. | 2·6 | 4·5 | 2·7 | 1·2 | 2·8 | 8·4 | 10·3 |
| March | 108 | S.E. | 1·3 | 2·4 | 0·7 | 0·8 | 1·3 | 8·4 | 10·0 |
| April | 161 | S.E. by S. | 4·4 | 3·3 | 1·8 | 1·3 | 2·7 | 8·6 | 10·1 |
| May | 100 | S.S.E. | 3·6 | 3·2 | 4·0 | 2·4 | 3·3 | 7·2 | 9·4 |
| June | 106 | W.S.W. | 6·0 | 5·6 | 9·2 | 7·6 | 7·1 | 3·5 | 7·7 |
| July | 81 | S.W. by S. | 7·1 | 5·8 | 6·2 | 6·1 | 6·3 | 4·6 | 8·8 |
| August | 92 | W.S.W. | 6·8 | 5·6 | 7·6 | 6·2 | 6·6 | 4·6 | 9·1 |
| September | 49 | S.S.E. | 5·5 | 5·4 | 5·4 | 3·4 | 4·9 | 5·8 | 9·9 |
| October | 12 | N N.E. | 5·4 | 6·1 | 6·6 | 4·6 | 5·7 | 4·9 | 9·7 |
| November | 58 | N.E. by N. | 6·3 | 7·2 | 6·3 | 4·4 | 6·1 | 4·8 | 9·1 |
| December | 125 | N.N.E. | 6·5 | 6·7 | 6·7 | 5·6 | 6·4 | 4·6 | 8·3 |
| Annual | 29 | S E. by S. | 4·9 | 5·1 | 5·1 | 3·8 | 4·7 | 6·1 | ... |

MEAN Monthly and Annual Meteorological Results at the Madras Observatory in 1919.

| Month. | Barometer. | | Dry Bulb Thermometer. | | | | Wet Bulb. | | Tension of Vapour. | Relative Humidity. | Sun Max. in Vac. | Min. on Grass. | Wind. | | | Rain. | | Cloudy sky. | Bright Sunshine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reduced to 32°. | Daily Range. | Mean. | Max. | Min. | Range. | Mean. | Min. | By Simpson's Tables. | | | | Daily Velocity. | Mean Direction. | | Amount. | Days. | | |
| | Inches. | Inches. | ° | ° | ° | ° | ° | ° | Inches. | Cents. | ° | ° | Miles. | Points | Points. | Inches. | No. | Cents. | Hours. |
| January | 29·998 | 0·117 | 78·3 | 85·3 | 72·1 | 13·2 | 73·4 | 70·6 | 0·758 | 78 | 150·6 | 69·2 | 87 | 6 | E.N.E. | 0·37 | 1 | 36 | 225·0 |
| February | ·981 | ·116 | 79·7 | 87·7 | 71·4 | 16·3 | 73·6 | 70·3 | ·746 | 74 | 154·4 | 68·4 | 91 | 10 | E.S.E. | . | . | 28 | 233·9 |
| March | ·941 | ·130 | 80·5 | 88·9 | 72·0 | 16·9 | 74·5 | 70·9 | ·771 | 74 | 153·1 | 69·6 | 117 | 12 | S.E. | 1·96 | 2 | 13 | 261·0 |
| April | ·829 | ·133 | 85·3 | 93·6 | 78·7 | 14·9 | 79·1 | 76·8 | ·908 | 75 | 155·2 | 76·9 | 173 | 13 | S.E. by S. | ... | ... | 27 | 258·3 |
| May | ·747 | ·114 | 88·3 | 99·3 | 81·3 | 18·0 | 79·1 | 76·3 | ·869 | 65 | 157·5 | 80·0 | 156 | 15 | S. by E. | 0·03 | 2 | 33 | 224·4 |
| June | ·669 | ·116 | 87·4 | 98·8 | 80·8 | 18·0 | 77·0 | 74·0 | ·784 | 61 | 144·7 | 79·8 | 175 | 21 | S.W. by W. | 2·49 | 12 | 71 | 105·3 |
| July | ·709 | ·123 | 84·3 | 94·3 | 78·2 | 16·1 | 77·4 | 74·3 | ·846 | 73 | 143·2 | 76·9 | 146 | 19 | S.W. by S. | 6·16 | 12 | 63 | 143·1 |
| August | ·746 | ·125 | 86·0 | 96·5 | 79·0 | 17·5 | 77·3 | 73·8 | ·816 | 66 | 150·0 | 77·0 | 146 | 21 | S.W. by W. | 3·12 | 8 | 66 | 143·8 |
| September | ·795 | ·132 | 83·2 | 91·8 | 76·9 | 14·9 | 78·5 | 75·7 | ·906 | 80 | 150·8 | 75·3 | 84 | 14 | S.S.E. | 6·78 | 10 | 49 | 174·3 |
| October | ·857 | ·119 | 81·7 | 89·2 | 76·3 | 12·9 | 77·5 | 74·5 | ·884 | 82 | 152·0 | 74·7 | 63 | 3 | N.E. by N. | 10·80 | 16 | 57 | 151·1 |
| November | ·859 | ·107 | 79·5 | 86·2 | 74·4 | 11·8 | 73·4 | 76·0 | ·850 | 84 | 145·2 | 72·7 | 86 | 4 | N.E. | 12·83 | 14 | 61 | 143·8 |
| December | ·950 | ·108 | 77·2 | 83·4 | 72·3 | 11·1 | 70·3 | 72·9 | ·749 | 80 | 141·1 | 70·5 | 141 | 3 | N.E. by N. | 6·24 | 13 | 64 | 142·3 |
| Annual | 29·840 | 0·119 | 82·6 | 91·2 | 76·1 | 15·1 | 75·9 | 73·8 | 0·824 | 74 | 149·8 | 74·3 | 122 | 12 | S.E. | 50·78 | 90 | 47 | 2206·3 |

EXTREME Monthly Meteorological Records at the Madras Observatory in 1919.

| Month. | Barometer. | | | | | Dry Bulb Thermometer. | | | | Wet Bulb. | | Humidity. | | Sun Th. in Vacuo. | | Grass Therm. | | Wind. | | | | Rain. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | | Lowest. | | Range. | Highest. | | Lowest. | | Lowest. | | Lowest. | | Highest. | | Lowest. | | Highest. | | Lowest. | | Greatest Fall. | |
| | Inches. | Day. | Inches. | Day. | Inches. | ° | Day. | ° | Day. | ° | Day. | Cents. | Day. | ° | Day. | ° | Day. | Miles. | Day. | Miles. | Day. | Inches. | Day. |
| January | **30·130** | **6, 15** | 29·872 | 25 | 0·258 | 87·4 | 30 | **64·5** | **2** | **63·5** | **2** | 57 | 1 | 155·6 | 19 | **61·2** | **2** | 182 | 6 | 34 | 30 | 0·37 | 4 |
| February | ·121 | 5 | ·820 | 18 | ·301 | 93·5 | 18 | 68·4 | 23 | 67·4 | 23 | 54 | 24 | 162·8 | 12 | 65·2 | 23 | 126 | 18 | 43 | 1 | .. | ... |
| March | ·061 | 20 | ·761 | 31 | ·300 | 94·9 | 31 | 66·4 | 10 | 64·6 | 10 | 48 | 9 | 159·2 | 2 | 69·6 | 10 | 196 | 18 | 65 | 8 | 1·72 | 20 |
| April | 29·962 | 21 | ·796 | 13 | 166 | 98·3 | 23 | 73·7 | 5 | 72·7 | 5 | 43 | 23 | 163·6 | 23 | 71·3 | 5 | 248 | 24 | 111 | 5 | | ... |
| May | ·885 | 3 | ·579 | 31 | ·306 | **108·2** | **21** | 76·5 | 9 | 72·4 | 19 | 29 | 22 | 165·6 | 20 | 75·2 | 9 | 205 | 5 | 124 | 13 | 0·02 | 8 |
| June | ·792 | 23 | ·523 | 30 | ·269 | 105·0 | 18 | 70·2 | 3 | 69·7 | 3 | **25** | **18** | 159·1 | 2 | 70·5 | 3 | 245 | 14 | 50 | 4 | 0·91 | 3 |
| July | ·846 | 14 | **·519** | **30** | ·327 | 102·2 | 3 | 73·5 | 11 | 72·3 | 2 | 35 | 1 | 154·3 | 4 | 72·9 | 11 | 200 | 4 | 86 | 20 | 1·25 | 9 |
| August | ·858 | 6 | ·602 | 1 | ·256 | 101·1 | 14 | 74·0 | 22 | 71·3 | 24 | 34 | 13, 14 | 162·0 | 29 | 73·2 | 5 | 201 | 14 | 97 | 20 | 0·97 | 18 |
| September | ·961 | 11 | ·606 | 1 | **·355** | 99·0 | 1, 2 | 73·3 | 15 | 72·9 | 15 | 38 | 1 | **164·5** | **12** | 72·2 | 5 | 140 | 6 | 32 | 24 | **3·18** | **28** |
| October | ·963 | 14 | ·721 | 6 | ·241 | 96·2 | 8 | 73·1 | 23 | 71·6 | 23 | 57 | 15 | 163·0 | 19 | 67·9 | 20 | 96 | 22 | **24** | **14** | 2·62 | 31 |
| November | 30·023 | 24 | ·699 | 13 | ·324 | 90·6 | 17 | 70·5 | 26 | 69·8 | 26 | 62 | 18, 25 | 158·4 | 13 | 67·3 | 26 | 200 | 30 | **24** | **19** | 3·08 | 5 |
| December | ·110 | 19 | ·795 | 14 | ·315 | 86·3 | 17 | 67·4 | 11 | 64·8 | 21 | 54 | 11 | 157·4 | 16 | 64·1 | 11 | **320** | **30** | **24** | **14** | 1·76 | 31 |

# ANNUAL REPORT

OF THE

# DIRECTOR KODAIKANAL AND MADRAS OBSERVATORIES

FOR 1920

MADRAS:
PRINTED BY THE SUPERINTENDENT, GOVERNMENT PRESS.

1921.

# KODAIKANAL AND MADRAS OBSERVATORIES.

## REPORT FOR THE YEAR 1920.

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### II.—Madras Observatory.

# KODAIKANAL AND MADRAS OBSERVATORIES.

## I.—REPORT OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1920.

*Staff.*—The staff of the Observatory on December 31, 1920, as reorganised by the Government of India, was as follows:—

| | |
|---|---|
| Director ... ... ... ... | J. Evershed, F.R.S. |
| Assistant Director ... ... ... | T. Royds, D.Sc. |
| Assistants ... ... ... ... | A. A. Narayana Ayyar, B.A.<br>P. R. Chidambara Ayyar, B.A.<br>S. S. Ramaswami Ayyangar, B.A.<br>S. Balasundaram Ayyar. |
| Recorders ... ... ... ... | L. N. Krishnaswami Ayyar.<br>R. Krishna Ayyar.<br>S. N. Krishna Ayyar. |
| Temporary Recorder ... ... | K. R. Viswanatha Ayyar. |

The subordinate staff consists of a book-binder, an assistant book-binder, a mechanic, six peons, one boy peon for the dark room and two lascars.

The Director was absent on combined leave from 26th May to 15th December 1920, Dr. Royds acting as Director and Mr. A. A. Narayana Ayyar as Assistant Director.

2. *Buildings and grounds.*—The Magnetic Observatory and the two domes in the main building were painted during the year and the Department of Public Works was engaged at the end of the year in extending the motor house in order to make it suitable for a new pump. Repairs to the wire fencing of the Observatory compound referred to in the last report have not yet been completed.

3. *Instruments.*—The 15-inch lens borrowed from the Nizamiah Observatory has been in constant use during the year for spectrographic research work. A 30° reflecting prism of 4-inch effective aperture has been received from Messrs. Hilger, Limited. It is intended to use this prism in combination with two 45° prisms for the H$\alpha$ spectroheliograph, replacing the Michelson grating at present in use. Some preliminary tests of the performance of the combination encourage the hope of getting improved results with much shorter exposures.

4. *Weather conditions.*—The rainfall for the year was again in excess of the average, and the conditions in some months were very unfavourable for astronomical work. This applies especially to the month of November when there were twelve consecutive days when no solar observations were possible. The mean definition in the north dome before 10 a.m. was 2·9 on a scale in which 1 is the worst and 5 the best. There were thirty-four days only when the morning definition was estimated as 4 or over.

5. *Photoheliograph.*—Photographs on a scale of 8 inches to the Sun's diameter were taken on 321 days, using the 6-inch visual achromatic object glass and a green colour screen.

6. *Spectroheliographs.*—Monochromatic images of the Sun's disc in K light were obtained on 331 days, prominence plates on 286 days and H$\alpha$ disc plates on 273 days.

7. *Six-inch Cooke equatorial and spectroscope.*—Work with this instrument has been continued on the same lines as formerly for visual observations of solar phenomena which cannot be readily photographed.

8. *Grating spectrograph.*—Photographs of sunlight and iron arc spectra were obtained during every month of the year, and spectra of sunlight reflected by Venus were photographed on fifty mornings during January, February and March, and on eight evenings in December. Spectrum photographs were also obtained of sections of the Sun's disc including sunspots when the definition was good and other conditions favourable.

Measures of the sunlight and Fe arc spectra by Mr. Narayana Ayyar, indicate a rather large range of variation in the shifts of the solar lines, and his mean values for the year are in excess of those for 1919 by about 0·002 A. Measures of the Venus spectra taken early in the year when the angle Venus-Sun-Earth exceeded 90° give mean shifts about 0·005 A. smaller than those measured in the control plates of direct sunlight. The December plates so far as they have been measured give nearly normal values, the angle at the Sun being then about 70°.

Trials of the effect of altitude gave negative results, the wave-lengths measured when the planet was at a mean altitude of 20° being the same as those observed at a mean altitude of 40°.

By the use of Barnet "Ultra Rapid" plates hypersensitised with ammonia it has been possible to photograph Venus spectra with a very narrow slit, and these are the finest plates hitherto obtained. They give no evidence of an inclination of the lines due to a rotation of the planet when the terminator is placed normal to the slit.

A special ultra-violet spectrograph was erected temporarily, using a parabolic grating and a quartz collimating lens. Spectra were obtained of the east and west limbs of the Sun in the region of the ammonia band at λ 3360, and it was demonstrated by the displacements due to the solar rotation that this band is of solar and not telluric origin.

Some comparison spectra of Venus, and of sunlight reflected from white paper, have been obtained with the prism spectrograph and parabolic mirror, to get evidence on the absorbing effect of Venus' atmosphere.

Measures of the displacements, Sun — arc, of some of the cyanogen bands in the first head near λ 3883 have been completed and published in Kodaikanal Observatory Bulletin No. 64.

*Summary of sunspot and prominence observations.*

9. *Sunspots.*—The following table shows the monthly numbers of new groups observed at Kodaikanal, and their distribution between the northern and southern hemispheres. The mean daily numbers of spots visible are also given :—

| — | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups .. ... | 11 | 19 | 13 | 10 | 18 | 12 | 9 | 9 | 9 | 12 | 7 | 12 | 141 |
| North ... ... | 6 | 9 | 6 | 5 | 12 | 6 | 4 | 5 | 4 | 7 | 4 | 4 | 72 |
| South ... . | 5 | 10 | 7 | 5 | 6 | 6 | 5 | 4 | 5 | 5 | 3 | 8 | 69 |
| Daily numbers ... | 2·9 | 4·4 | 2·9 | 1·4 | 2·7 | 2·7 | 2·3 | 1·8 | 2·0 | 3·5 | 1·9 | 2·8 | 2·6 |

Compared with the year 1919 there was a decrease of 40 per cent in the case of new groups. The decrease is much greater in the southern hemisphere than in the northern.

The approximate mean latitude of the spots was 11°·1 in both hemispheres.

An extensive group of spots, which during its first apparition crossed the central meridian on January 1–2, returned no less than five times,

and finally disappeared in May. It is noteworthy that the meridian passsages were on all occasions associated with magnetic storms. The very great storm of March 22nd and 23rd was one of these and occurred during the fourth meridian passage of the group.

The number of bright reversals of the H$\alpha$ line in the neighbourhood of spots was 298 whilst the number of displacements of this line observed near spots was 169. There were 129 dark reversals of $D_3$ observed, whilst only 57 were seen in 1919. The increase is probably connected with the increase in number and area of the H$\alpha$ absorption markings, indicating increased density in the prominences both of hydrogen and helium.

10. *Prominences.*—The mean daily areas in square minutes of arc, derived from the photographic records are as follows :—

| | North. | South. | Total. |
|---|---|---|---|
| 1920—January to June ... ... | 1·99 | 2·34 | 4·33 |
| July to December ... | 2·10 | 2·17 | 4·27 |

These figures show a slight increase over those of the previous year. The mean numbers increase from 13·2 for the first half year to 15·9 for the second.

The general distribution in latitude has remained essentially the same as in 1919 notwithstanding some fluctuations in the different zones of activity, and between the northern and southern hemispheres. No large prominences have been observed in the polar regions above latitude 60°.

Metallic prominences were fairly numerous in the sunspot zones, and displacements of the hydrogen lines were also frequent. The displacements towards red again slightly exceed those towards violet at the limb, and on the disc near spots 73 per cent of the whole number were towards red.

Prominences photographed on the disc as absorption markings show an increase in area of 38 per cent compared with 1919 ; their distribution in latitude was identical with that of the limb prominences.

A striking change has occurred in the distribution between east and west. In previous years up to 1919 there has always been an excess of absorption markings on the eastern hemisphere of the Sun, but in 1919 this excess was negligibly small and in 1920 there is a marked excess west of the meridian, the areas of those on the east side being only 47·5 per cent of the whole. About the same western preponderance is shown also by the prominences at the limb, and the western prominences were also about 14 per cent brighter than those on the east limb.

A great eruptive prominence was photographed on December 31, on the west limb. It bore a striking resemblance to the prominence of 1919 May 29 and occupied the same region of latitude, extending from + 5° to − 42° as an immense arch. Between $8^h$ and $10^h$ I.S.T. the prominence reared up to a great height and rapidly faded, the highest parts ascending to 16′ above the limb.

In a detailed study of the H$\alpha$ plates Dr. Royds has brought out several new features regarding the absorption markings (see Kodaikanal Observatory Bulletin, No. 63) and in studying the prominence data for the interval 1913—1920 for periodicities he finds that periods of 13 and 7½ months are the principal features of the periodogram, as was the case also during the interval 1905—1912.

11. *Magnetic observations.*—Continuous magnetograph records are obtained of declination, vertical force, and horizontal force. Absolute observations for dip are made daily excepting Sundays, declination and horizontal force on three days per week alternately. All the records are

made over to the Magnetic Survey Office, Dehra Dun, and the results are published by the Survey annually.

Twenty-eight "Great" and 126 "Moderate" magnetic storms were registered during the year. The storm commencing March 22, $9^h$ $14^m$ was one of the greatest recorded at Kodaikanal, and during the more violent fluctuations there was considerable disturbance of the Indian Telegraph service. This storm occurred during the meridian passage of a great spot group, and, as mentioned on page 3, magnetic storms were recorded at every meridian passage of the group, that is, during five solar rotations from January 1st to April 18th, at 27 day intervals. Subsequent records show that while the spot disturbance had subsided in May, magnetic storms continued to recur at 27 day intervals during 7 more solar rotations. The storms of April 18th and May 14th were recorded as "Great," those of June 11th, July 8th, August 4th and August 30th as "Moderate," September 27th as "Great," October 24th and November 21st as "Moderate."

12. *Pyrheliometer.*—Measures of the solar radiation were made by Dr. Royds with the Angstrom pyrheliometer No. 73 on cloudless days whenever opportunity offered, and the results are given in the following table. In this E is the solar constant, or the amount of heat which would be received outside the earth's atmosphere, in calories per square centimeter per minute and *a* is the transmissive power of the earth's atmosphere. The instrumental constant supplied by the makers has been used to determine E but the values require to be multiplied by an undetermined factor in order to compensate for the absorptive power of the pyrheliometer being less than its assumed value.

| Date. | E. | *a*. | Remarks. | Date. | E. | *a*. | Remarks. |
|---|---|---|---|---|---|---|---|
| 1920. | | | | 1920. | | | |
| January 21 ... | 1·820 | 0·878 | Forenoon. | February 16 ... | 1·732 | 0·884 | |
| ,, 21 ... | 1·902 | 0·867 | Afternoon. | ,, 17 .. | 1·710 | 0·878 | |
| ,, 27 .. | 1·856 | 0·848 | | ,, 23 ... | 1·749 | 0·901 | |
| ,, 28 ... | 1·766 | 0·863 | | ,, 24 ... | 1·778 | 0 900 | |
| February 4 .. | 1·692 | 0·909 | | ,, 25 ... | 1·783 | 0·903 | |
| ,, 9 ... | 1·778 | 0·865 | | March 1 | 1 738 | 0·908 | |
| ,, 11 ... | 1·830 | 0·881 | | ,, 8 ... | 1 740 | 0·869 | |

13. *Time.*—The error of the standard clock is usually determined by reference to the 16 hour signal from the Madras Observatory. This is rendered possible by the courtesy of the Telegraph Department which permits the Madras wire to be joined through to this Observatory. The signal is received with accuracy on most days and all failures are at once reported to the Postmaster-General, Madras.

14. *Meteorology.*—Eye observations are made at $8^h$, $10^h$ and $16^h$ local mean time as in former years. The Richard thermograph (wet and dry bulb) and barograph, the Beckley anemograph, and the sunshine recorder also continue in use. Cloud observations with the Nephoscope are made three times daily. The meteorological means for 21 years have been worked out and are printed as appendix VI with this report. There is little change in the adopted mean values excepting rainfall which is now 61·89 inches instead of 59·55, and the mean temperature has increased from 56°·3 to 57°·0. In the following paragraphs "mean" values refer to the new 21 year averages.

*Pressure.*—The mean pressure for the year was normal. The monthly means show that it was below normal in January, March, April and November and above normal in February, May, June and July. The highest pressure recorded was 22·946 inches on January 8, and the lowest 22·671 on October 5.

*Temperature.*—The monthly mean temperature in the shade was above normal in all months except January. The highest temperature

recorded during the year was 75°·5 on May 8, and the lowest was 39°·6 on December 23. The maximum temperature in the sun was below normal by 16° in September and November. In the remaining months it was not far from normal. The lowest minimum on grass was 24°·1 on December 28.

*Humidity.*—The mean humidity for the year was 1 cent below normal. The driest days in the year were January 18 and March 25 when the humidity was 7 cents only.

*Rainfall.*—The total rainfall was 65·46 inches or 3·57 inches above normal. There was an excess of 5·89, 5·58 and 7·71 inches in January, September and November, respectively. The greatest defect was 4·68 and 4·02 inches in the months of October and December respectively. The driest month was March with only 0·10 inch.

*Wind.*—The wind directions were nearly normal in all months except May, October, November and December. The air movement was below normal in January, and from April to September inclusive and in December. It was above normal in February.

*Transparency of the atmosphere.*—The transparency of the lower atmosphere as judged by the visibility of the Nilgiris about 100 miles distant was much below the average.

*Cloud and sunshine.*—The percentage of clear sky was above normal in February and December, and below normal in April and November. During the other months it was normal. The total number of hours of bright sunshine was 2258 which is 5 per cent above normal. The total number of hours of sunshine in November was 59·2 only, the average being 132·8.

15. *Seismology.*—The Milne horizontal pendulum recorded eighty-five earthquakes, as against ninety during the previous year. Details of the records are given in Appendix I.

16. *Library.*—Eighty volumes were bound during the year.

17. *Publications.*—Four bulletins with the following titles were published during the year:—

No. LXII. Summary of prominence observations for the second half of the year 1919, by J. Evershed, F.R.S.

No. LXIII. Some features of H$\alpha$ dark markings on the sun, by T. Royds, D.Sc.

No. LXIV. On the displacements of the triplet bands near $\lambda$ 3883 in the solar spectrum, by J. Evershed, F.R.S.

No. LXV. Summary of prominence observations for the first half of the year 1920, by T. Royds, D.Sc.

In addition the Director has contributed an article with the following title " The displacement of the lines in the solar spectrum and Einstein's prediction "—Observatory 43, 153.

KODAIKANAL,
1st *February* 1921.

J. EVERSHED,
*Director, Kodaikanal and Madras Observatories.*

## II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1920.

*Staff.*—The staff of the Observatory during the year 1920 was as follows :—

| | |
|---|---|
| Deputy Director ... ... ... ... | Edward Barnes (January 1 to April 30)<br>C. Chengalvaraya Mudaliyar (May 1 to June 30).<br>Edward Barnes (July 1 to December 31). |
| Time Assistant ... ... ... ... | S. Solomon Pillai (January 1 to October 24). |
| Observers ... ... ... ... ... | C. Chengalvaraya Mudaliyar (January 1 to July 2).<br>P. Jayaram Mudaliyar (January 1 to December 31).<br>S. S. Ranga Acharya (July 3 to December 31). |

A revised scale of pay was sanctioned by the Government of India for the non-gazetted staff of the Madras Observatory with effect from 1st July 1920 and the designations "Computer" and "Assistants" were changed to "Time Assistant" and "Observers", respectively.

Mr. S. Solomon Pillai was absent on privilege leave from 1st to 27th May and on leave on private affairs from 28th May to 30th June. He retired from service on the evening of 24th October.

Mr. C. Chengalvaraya Mudaliyar was transferred to the Meteorological office as Weather Assistant on July 2. Mr. S. S. Ranga Acharya was transferred from Kodaikanal to Madras and took up his duties as Observer on July 3.

2. *Time service.*—The time gun at Fort St. George failed on 27 occasions out of 732 giving a percentage of success of 96·3. Although most of the failures were due to faults outside the Observatory, yet it would appear to be desirable that the apparatus and instruments both at the Observatory and at the Fort be completely renewed. These have been in use for many years and have become much worn. The gun was fired at 8 hrs and 11 hrs instead of at 12 hrs on November 11 on account of the anniversary of the armistice. The time ball at the Harbour failed altogether on one day. On four other days it failed at 13 hrs but dropped correctly at 14 hrs. The 16 hr roll of signals was sent to the Central Telegraph Office on every day.

3. *Meteorological observations.*—Eye observations were made daily at 8 hrs, 10 hrs, 16 hrs and 20 hrs local mean time as in former years, and the records of self-registering instruments were maintained as usual. Extra observations were taken for storm warning purposes and telegrams were sent to Calcutta on 36 occasions and to Simla on three occasions.

4. *Buildings.*—The usual annual repairs to the office and quarters were carried out during the year.

5. *Instruments.*—The following is a list of instruments at the Observatory on 31st December 1920 :—

*(a) Astronomical.*

Eight-inch Equatorial Telescope—Troughton and Simms.
Sidereal clock—Haswall.
Do. Dent, No. 1408.
Do. S. Riefler, No. 61.
Mean Time clock—J. H. Agar Baugh, No. 105.
Do. with galvanometer—Shepherd & Sons.

Meridian circle—Troughton and Simms.
Portable transit instrument—Dollond.
Tape chronograph—R. Fuess.
Relay for use with the chronograph—Siemens.

(*b*) *Meteorological.*

Richard's barograph—No. 10, L. Casella.
Do. thermograph—No. 29637, L. Casella.
Peander's self-recording rain-gauge—No. 116, Lawrence and Mayo.
Beckley's anemograph—Adie.
Sunshine recorder—No. 149, L. Casella.
Nephoscope—Mons Jules Daboseq and Ph. Pellin.
Barometer, Fortin's—No. 1771, L. Casella.
Do. do. No. 725, L. Casella (spare).
Do. do. No. 1420, L. Casella (spare).
Dry bulb thermometer—No. 94221, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Wet bulb thermometer—No. 94219, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Dry maximum thermometer—No. 8581, Negretti and Zambra.
Dry minimum do. No. 69017, L. Casella.
Wet do. do. No. 91753, Negretti and Zambra.
Sun maximum do. No. 127618, Negretti and Zambra.
Grass minimum do. No. 3377, Negretti and Zambra.
Rain-gauge (8″ diameter)—No. 1042, Negretti and Zambra.
Measure glass for above.
Rain-gauge (5″ diameter).
Measure glass for above.
Stop watch—No. A 3.

The level error of the Transit Circle at the beginning of the year was $0^s{\cdot}23$. It changed gradually till it reached its maximum negative value $-10^s{\cdot}19$ in the third week of October. As a result of continued and heavy rain during the remainder of the month it went through a rapid change in the reverse direction. This change continued during November, by the end of which a value of $-2^s{\cdot}18$ had been attained. After a slight rise, it remained fairly steady at about $-2^s{\cdot}56$ during December. The rate of the Riefler clock has varied considerably during the year. This may be due partly to the somewhat abnormal meteorological conditions, but this would not appear to entirely account for the behaviour.

6. *Weather summary.*—The following is a summary of the meteorological conditions at Madras during 1920 :—

*Pressure.*—The mean monthly pressure was normal in February, April, May and October, above normal in August and below normal during the other months. The greatest excess was 0·013 inch in August while the greatest deficiency was 0·048 inch in November. The highest pressure recorded was 30·116 inches on January 8.

*Temperature.*—The mean temperature of the air was normal in April, May and December and above normal throughout the remainder of the year. The maximum shade temperature was normal in January, March, April, October and November and above normal during the other months. The highest temperature recorded was 108°·7 on the 6th May. The minimum in shade was normal in April and May, below normal in December and above normal during the other months. The lowest temperature recorded was 62°·8 on December 4. The highest sun maximum was 166°·7 on April 19 and the lowest on grass 58°·8 on December 4.

*Humidity.*—The percentage of humidity was about normal throughout the year. The driest day in the year was June 23.

*Wind.*—The wind velocity was above the average in November, but it was in defect in all other months. The wind direction was almost normal during the year.

*Cloud.*—The amount of cloud was above normal in April and November, below normal in February, June and December and about normal during the other months.

*Sunshine.*—The percentage of sunshine was normal in August, above normal in February, June, September and December and below normal during the other months. The total number of hours of bright sunshine during the year was 2362·2.

*Rainfall.*—The rainfall was above the average in January, October and November and below in the remaining months. The greatest excess was 16·87 inches in November and the greatest defect 5·27 in December. The total fall for the year was 63·89 inches on 78 days compared with an average of 49·02 inches. The monsoon rainfall from 15th October to the end of the year was 50·22 inches. The heaviest rainfall on one day was 7·61 inches on October 27.

*Storm.*—A storm passed over the extreme south of the Presidency during the first few days in January and caused heavy rain on the Coromandel Coast. During the year several disturbances approached the Circars Coast but passed away to the north. Towards the end of October a shallow depression formed in the south of the Bay and caused very heavy rain over the south of the Presidency. During the third week of November, conditions were very disturbed in the south-west of the Bay and the exceptionally heavy rains received in the south of the Carnatic caused serious floods and interrupted railway and telegraphic communication with Ceylon and the extreme south for several days. Negapatam received as much as 32·85 inches of rain in 10 days at this period.

THE OBSERVATORY,
MADRAS, 14*th January* 1921.

EDWARD BARNES,
*Offg. Deputy Director.*

# APPENDIX I.

## STATION—KODAIKANAL OBSERVATORY.

### SEISMIC RECORDS.

$\phi = 10° 13' 50''$ $\lambda = 77° 28' 00''$ $h = 2343$ metres. *Subsoil*—Rock.

*Apparatus*—Milne's Horizontal Pendulum Seismograph.

| 1920. | $T_o$ | $\frac{T}{T_o^2}$ | 1920. | $T_o$ | $\frac{T}{T_o^2}$ |
|---|---|---|---|---|---|
| January ... ... ... | 17·8 | 2·8 | July ... .. .. | 18·0 | 2·6 |
| February ... .. ... | 17·9 | 2·8 | August .. ... ... | 18·1 | 2·6 |
| March .. ... ... | 18·0 | 2·6 | September .. | 18·3 | 2·5 |
| April ... ... ... | 18·0 | 2·7 | October ... ... | 18·0 | 2·5 |
| May .. .. . | 18·2 | 2·6 | November .. ... | 17·6 | 2·8 |
| June ... ... ... | 18·3 | 2·5 | December ... .. .. | 17·7 | 2·6 |

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period. (Sec.). | Amplitude ($\mu$). An. | Ae. | Az. | Distance $\triangle$ (Km.). | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1920. | | | | | | | | | | |
| 1 | January 8 ... | eP | 9 | 04 | 06 | ... | ... | . | ... | .. | Widening of line. |
| | | F | 9 | 07 | 06 | ... | ... | ... | ... | ... | |
| 2 | 9 ... | eP | 4 | 39 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 4 | 43 | 06 | ... | ... | ... | ... | ... | |
| 3 | 12 ... | eP | 14 | 17 | 24 | ... | ... | ... | .. | ... | Widening of line. |
| | | F | 14 | 21 | 30 | ... | . | | | ... | |
| 4 | 22 ... | eP | 16 | 44 | 06 | ... | ... | ... | ... | ... | Widening of line.. |
| | | F | 16 | 52 | 18 | ... | ... | ... | | ... | |
| 5 | February 2 ... | eP | 11 | 34 | 06 | ... | | . | . | ... | |
| | | eL | 11 | 45 | 24 | ... | ... | ... | | ... | |
| | | M | 12 | 17 | 30 | .. | .. | 1310 | .. | .. | |
| | | F | 15 | 45 | 30 | .. | ... | .. | ... | .. | |
| 6 | 8 ... | eP | 5 | 49 | 12 | ... | ... | ... | | ... | |
| | | eL | 5 | 55 | 24 | .. | ... | | | ... | |
| | | M | 5 | 57 | 24 | .. | ... | 50 | ... | ... | |
| | | F | 6 | 08 | 12 | ... | ... | .. | ... | ... | |
| 7 | 10 | eP | 10 | 03 | 30 | ... | ... | | ... | ... | |
| | | eL | 10 | 06 | 30 | ... | ... | | | .. | |
| | | M | 10 | 08 | 36 | . | ... | 40 | .. | ... | |
| | | F | 10 | 20 | 48 | ... | ... | ... | .. | ... | |
| 8 | 10 ... | eP | 23 | 10 | 36 | .. | .. | | ... | ... | |
| | | eL | 23 | 31 | 06 | ... | ... | ... | ... | ... | |
| | | M | 23 | 33 | 12 | ... | ... | 60 | ... | | |
| | | F | 23 | 58 | 18 | .. | ... | ... | ... | ... | |
| 9 | 27 ... | iP | 3 | 57 | 24 | ... | . | ... | | ... | Instrument examined at $4^h$ $3^m$. G.M.T. |
| | | L | | ? | | ... | ... | .. | | ... | |
| | | M | | ? | | ... | ... | ... | .. | .. | |
| | | F | | ? | | ... | ... | ... | ... | | |
| 10 | March 11 | eP | 12 | 30 | 00 | ... | .. | ... | ... | .. | Widening of line. |
| | | F | 12 | 36 | 00 | ... | . | ... | ... | ... | |
| 11 | 12 ... | eP | 16 | 00 | 00 | .. | .. | . | ... | ... | Widening of line. |
| | | F | 16 | 03 | 18 | ... | ... | ... | ... | ... | |
| 12 | 15 ... | eP | 10 | 21 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 10 | 23 | 36 | . | .. | .. | ... | | |
| 13 | 15 .. | eP | 10 | 42 | 06 | ... | ... | ... | .. | ... | Widening of line. |
| | | F | 12 | 49 | 18 | ... | | .. | ... | ... | |
| 14 | 17 ... | eP | 18 | 45 | 06 | | .. | ... | . | ... | |
| | | eL | 18 | 47 | 36 | .. | . | ... | ... | ... | |
| | | M | 18 | 50 | 12 | ... | .. | 150 | ... | ... | |
| | | F | 19 | 08 | 36 | ... | .. | .. | .. | .. | |
| 15 | 19 | eP | 10 | 10 | 12 | ... | .. | ... | ... | ... | Widening of line. |
| | | F | 10 | 12 | 00 | .. | ... | ... | ... | ... | |
| 16 | 20 ... | eP | 19 | 24 | 24 | ... | | .. | ... | ... | |
| | | eL | 19 | 53 | 42 | ... | . | | ... | . | |
| | | M | 20 | 07 | 06 | ... | ... | 100 | ... | .. | |
| | | F | 20 | 41 | 54 | ... | ... | .. | | ... | |
| 17 | 22 ... | eP | 21 | 02 | 48 | ... | .. | ... | ... | ... | Widening of line. |
| | | F | 21 | 14 | 06 | ... | ... | ... | ... | ... | |
| 18 | 30 ... | eP | 23 | 42 | 18 | ... | ... | .. | ... | ... | Widening of line. |
| | | F | 23 | 44 | 36 | ... | .. | | ... | ... | |
| 19 | 31 ... | eP | 8 | 39 | 12 | ... | ... | .. | ... | .. | Widening of line. |
| | | F | 8 | 41 | 48 | ... | ... | ... | ... | ... | |
| 20 | April 2 ... | eP | 1 | 57 | 42 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 2 | 01 | 48 | ... | .. | ... | ... | ... | |

| No. | Date. | | Phase. | Time G.M.T | | | Period. (Sec.). | Amplitude ($u$). | | | Distance △ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | H. | M. | S. | | AN. | AE | AZ | | |
| | 1920. | | | | | | | | | | | |
| 21 | April | 6 ... | eP | 19 | 48 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 19 | 50 | 30 | ... | ... | ... | ... | ... | |
| 22 | May | 2 ... | eP | 8 | 38 | 42 | ... | ... | ... | ... | ... | |
| | | | eL | 8 | 41 | 48 | ... | ... | ... | ... | ... | |
| | | | M | 8 | 43 | 48 | ... | ... | 100 | ... | ... | |
| | | | F | 9 | 11 | 00 | ... | ... | ... | ... | ... | |
| 23 | | 2 ... | eP | 14 | 57 | 12 | ... | ... | ... | ... | ... | |
| | | | eL | 15 | 00 | 12 | ... | ... | ... | ... | ... | |
| | | | M | 15 | 02 | 48 | ... | ... | 80 | ... | ... | |
| | | | F | 15 | 28 | 00 | ... | ... | ... | ... | ... | |
| 24 | | 7 ... | eP | 5 | 42 | 18 | ... | ... | ... | ... | ... | |
| | | | eL | 6 | 11 | 30 | ... | ... | ... | ... | ... | |
| | | | M | 6 | 14 | 42 | ... | ... | 340 | ... | ... | |
| | | | F | 6 | 55 | 00 | ... | ... | ... | ... | ... | |
| 25 | | 7-8 ... | eP | 21 | 53 | 54 | ... | ... | ... | ... | ... | |
| | | | eL | 22 | 19 | 42 | ... | ... | ... | ... | ... | |
| | | | M | 22 | 23 | 24 | ... | ... | 200 | ... | ... | |
| | | | F | 0 | 10 | 00 | ... | ... | ... | ... | ... | |
| 26 | | 10 ... | eP | 18 | 58 | 42 | ... | ... | ... | ... | ... | |
| | | | eL | 19 | 21 | 48 | ... | ... | ... | ... | ... | |
| | | | M | 19 | 23 | 00 | ... | ... | 80 | ... | ... | |
| | | | F | 19 | 56 | 06 | ... | ... | ... | ... | ... | |
| 27 | | 13 ... | eP | 2 | 08 | 00 | ... | ... | ... | ... | ... | |
| | | | eL | 2 | 31 | 30 | ... | ... | ... | ... | ... | |
| | | | M | 2 | 34 | 06 | ... | ... | 80 | ... | ... | |
| | | | F | 3 | 12 | 06 | ... | ... | ... | ... | ... | |
| 28 | | 19 ... | eP | 13 | 10 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 13 | 24 | 24 | ... | ... | | ... | ... | |
| 29 | | 20 ... | eP | 8 | 15 | 06 | ... | ... | ... | ... | ... | |
| | | | eL | 8 | 27 | 24 | ... | ... | | ... | ... | |
| | | | M | 8 | 30 | 00 | ... | ... | 100 | ... | ... | |
| | | | F | 8 | 52 | 36 | ... | ... | ... | ... | | |
| 30 | | 27 ... | eP | 6 | 03 | 18 | ... | ... | ... | ... | | Widening of line. |
| | | | F | 6 | 08 | 12 | ... | ... | ... | ... | ... | |
| 31 | June | 5 ... | eP | 4 | 31 | 18 | ... | ... | ... | ... | ... | |
| | | | iL | 4 | 26 | 54 | ... | ... | ... | ... | ... | |
| | | | M | 4 | 52 | 36 | ... | ... | 1250 | ... | ... | |
| | | | F | 7 | 21 | 18 | ... | ... | ... | ... | ... | |
| 32 | | 5 ... | eP | 12 | 18 | 18 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 12 | 20 | 18 | ... | ... | ... | ... | ... | |
| 33 | | 5 ... | eP | 18 | 31 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 18 | 34 | 06 | ... | ... | ... | | ... | |
| 34 | | 5 ... | eP | 18 | 41 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 19 | 08 | 48 | ... | ... | ... | | ... | |
| 35 | | 8 ... | eP | 14 | 09 | 48 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 14 | 12 | 24 | ... | ... | ... | ... | ... | |
| 36 | | 9 ... | eP | 11 | 44 | 24 | ... | ... | ... | | ... | |
| | | | eL | 11 | 55 | 36 | ... | ... | | ... | ... | |
| | | | M | 12 | 01 | 48 | ... | ... | 200 | ... | ... | |
| | | | F | 12 | 36 | 12 | ... | ... | ... | | ... | |
| 37 | | 10 ... | P | | ? | | ... | ... | ... | ... | ... | Instrument examined at $2^h$ $47^m$. |
| | | | eL | 2 | 56 | 54 | ... | | ... | ... | ... | |
| | | | M | 2 | 58 | 42 | ... | ... | 60 | ... | ... | |
| | | | F | 3 | 07 | 24 | ... | ... | ... | ... | ... | |
| | | | | | | | | | | | | Air tremors during high wind were frequent during the month of June |
| 38 | July | 1 ... | eP | 2 | 32 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 2 | 34 | 06 | ... | ... | ... | ... | ... | |
| 39 | | 1 ... | eP | 3 | 19 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 3 | 21 | 18 | ... | | ... | | ... | |
| 40 | | 1 ... | eP | 3 | 41 | 18 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 3 | 43 | 18 | ... | ... | ... | ... | ... | |
| 41 | | 1 ... | eP | 14 | 15 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 14 | 18 | 42 | ... | ... | ... | ... | ... | |
| 42 | | 1 ... | eP | 18 | 16 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 18 | 20 | 12 | ... | ... | ... | ... | ... | |
| 43 | | 2 ... | eP | 2 | 58 | 00 | ... | ... | ... | ... | ... | |
| | | | eL | 3 | 13 | 24 | ... | ... | ... | ... | ... | |
| | | | M | 3 | 16 | 00 | ... | ... | 100 | ... | ... | |
| | | | F | 3 | 44 | 12 | ... | ... | ... | ... | ... | |
| 44 | | 4 ... | eP | 9 | 15 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 9 | 21 | 12 | ... | ... | ... | ... | ... | |
| 45 | | 6 ... | eP | 3 | 59 | 24 | ... | ... | ... | ... | | Widening of line. |
| | | | F | 4 | 05 | 30 | ... | ... | ... | ... | | |

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period. (Sec.). | Amplitude ($\mu$). An. | Ae. | Az. | Distance $\triangle$ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1920. | | | | | | | | | | |
| 46 | July 6 ... | eP | 15 | 51 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 15 | 54 | 36 | ... | ... | ... | ... | | |
| 47 | 7 ... | eP | 19 | 43 | 18 | ... | ... | ... | | ... | Widening of line. |
| | | F | 19 | 47 | 24 | ... | ... | ... | ... | ... | |
| 48 | 8 ... | eP | 5 | 04 | 18 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 5 | 06 | 54 | ... | ... | ... | ... | ... | |
| 49 | 10 ... | eP | 10 | 19 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 10 | 21 | 06 | ... | ... | ... | ... | ... | |
| 50 | 10 ... | eP | 16 | 02 | 42 | ... | ... | ... | ... | ... | |
| | | eL | 16 | 09 | 18 | ... | ... | ... | ... | | |
| | | M | 16 | 11 | 54 | ... | ... | 50 | ... | ... | |
| | | F | 16 | 17 | 00 | ... | ... | ... | ... | ... | |
| 51 | August 2 ... | eP | 6 | 36 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 6 | 38 | 42 | ... | ... | ... | ... | ... | |
| 52 | 2 ... | eP | 7 | 00 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 7 | 01 | 48 | ... | ... | ... | ... | ... | |
| 53 | 15 ... | eP | 7 | 12 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 7 | 16 | 30 | ... | ... | ... | ... | ... | |
| 54 | 15 ... | eP | 8 | 34 | 06 | ... | ... | ... | ... | ... | |
| | | iL | 8 | 39 | 42 | ... | ... | ... | ... | | |
| | | M | 8 | 41 | 00 | ... | ... | 90 | ... | ... | |
| | | F | 9 | 45 | 18 | ... | ... | ... | ... | ... | |
| 55 | 20 ... | eP | 17 | 24 | 24 | ... | ... | ... | ... | ... | |
| | | iL | 17 | 35 | 36 | | ... | ... | ... | ... | |
| | | M | 17 | 38 | 54 | ... | ... | 170 | ... | ... | |
| | | F | 18 | 26 | 42 | ... | ... | ... | ... | ... | |
| 56 | 26–27 ... | eP | 23 | 54 | 48 | ... | ... | ... | ... | ... | |
| | | eL | 23 | 59 | 00 | ... | ... | | ... | ... | |
| | | M | 0 | 01 | 18 | ... | ... | 40 | ... | ... | |
| | | F | 0 | 18 | 00 | ... | | | ... | ... | |
| 57 | September 4 ... | eP | 14 | 47 | 06 | ... | ... | ... | ... | ... | |
| | | eL | 14 | 51 | 00 | ... | ... | ... | ... | ... | |
| | | M | 14 | 56 | 36 | ... | ... | 130 | ... | ... | |
| | | F | 15 | 41 | 30 | ... | ... | ... | ... | ... | |
| 58 | 6 ... | eP | 21 | 35 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 21 | 39 | 12 | | ... | | ... | ... | |
| 59 | 8 ... | eP | 2 | 05 | 54 | ... | ... | ... | ... | ... | |
| | | iL | 2 | 11 | 48 | | ... | ... | ... | ... | |
| | | M | 2 | 15 | 36 | ... | ... | 150 | ... | ... | |
| | | F | 3 | 10 | 00 | ... | ... | ... | ... | ... | |
| 60 | 9 .. | eP | 19 | 13 | 06 | ... | ... | ... | ... | ... | |
| | | eL | 19 | 53 | 36 | ... | ... | ... | ... | ... | |
| | | M | 19 | 59 | 12 | ... | ... | 140 | ... | ... | |
| | | F | 20 | 23 | 18 | | ... | ... | ... | ... | |
| 61 | 20 ... | eP | 14 | 52 | 36 | ... | ... | | ... | ... | |
| | | iL | 14 | 58 | 42 | ... | ... | ... | ... | ... | |
| | | M | 15 | 41 | 18 | ... | ... | 1020 | | ... | |
| | | F | 18 | 32 | 06 | ... | ... | ... | ... | ... | |
| 62 | 20 ... | eP | 23 | 52 | 36 | ... | ... | ... | | ... | Widening of line. |
| | | F | 23 | 54 | 36 | ... | ... | ... | ... | ... | |
| 63 | 21 ... | eP | 3 | 31 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 3 | 35 | 06 | ... | ... | ... | ... | ... | |
| 64 | 23 ... | eP | 6 | 19 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 6 | 21 | 06 | ... | ... | ... | ... | ... | |
| 65 | 24 ... | eP | 6 | 23 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 6 | 26 | 42 | ... | ... | ... | ... | ... | |
| 66 | October 12 ... | eP | 7 | 07 | 48 | ... | ... | ... | ... | ... | |
| | | eL | 7 | 17 | 30 | ... | ... | ... | ... | ... | |
| | | M | 7 | 21 | 06 | ... | ... | 50 | ... | ... | |
| | | F | 7 | 25 | 12 | ... | ... | ... | ... | ... | |
| 67 | 18 ... | eP | 8 | 25 | 24 | ... | ... | ... | ... | ... | |
| | | iL | 8 | 31 | 48 | ... | ... | ... | ... | ... | |
| | | M | 8 | 33 | 36 | ... | ... | 160 | ... | ... | |
| | | F | 9 | 56 | 42 | ... | ... | ... | ... | ... | |
| 68 | 20 ... | eP | 10 | 21 | 18 | ... | ... | ... | ... | ... | |
| | | eL | 10 | 29 | 30 | ... | ... | ... | ... | ... | |
| | | M | 10 | 30 | 30 | ... | ... | 50 | ... | ... | Hour signal at 10h 30m. |
| | | F | 10 | 55 | 36 | ... | ... | ... | ... | | |
| 69 | 22 ... | eP | 12 | 30 | 48 | ... | ... | ... | ... | ... | |
| | | eL | 13 | 30 | 30 | ... | ... | ... | ... | ... | |
| | | M | 13 | 32 | 36 | ... | ... | 90 | ... | ... | |
| | | F | 14 | 05 | 06 | ... | ... | ... | ... | ... | Hour signals at 12h 30m and 13h 30m. |
| 70 | 28 ... | eP | 8 | 19 | 12 | ... | ... | ... | ... | ... | |
| | | eL | 8 | 25 | 24 | ... | ... | ... | ... | ... | |
| | | M | 8 | 30 | 48 | ... | ... | 40 | ... | ... | |
| | | F | 8 | 33 | 06 | ... | ... | ... | ... | ... | |

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period. (Sec.). | Amplitude ($u$). An. | Ae. | Az. | Distance Δ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1920. | | | | | | | | | | |
| 71 | October 28 ... | eP | 13 | 10 | 30 | ... | ... | ... | ... | ... | |
| | | eL | 13 | 23 | 18 | ... | ... | ... | ... | ... | |
| | | M | 13 | 26 | 24 | ... | ... | 50 | ... | ... | |
| | | F | ... | | ? | ... | ... | ... | ... | ... | Overlapping. |
| 72 | 28 ... | eP | ... | | ? | ... | ... | ... | ... | ... | |
| | | eL | 14 | 09 | 00 | ... | ... | ... | ... | ... | |
| | | M | 14 | 20 | 18 | ... | ... | 120 | ... | ... | |
| | | F | 14 | 58 | 42 | ... | ... | ... | ... | ... | |
| 73 | November 3 ... | eP | 15 | 55 | 30 | ... | ... | ... | ... | ... | |
| | | eL | 16 | 07 | 48 | ... | ... | ... | ... | ... | |
| | | M | 16 | 08 | 48 | ... | ... | 40 | ... | ... | |
| | | F | 16 | 17 | 00 | ... | ... | ... | ... | ... | |
| 74 | 13 ... | eP | 19 | 34 | 06 | ... | ... | ... | | ... | Widening of line. |
| | | F | 19 | 37 | 12 | ... | ... | ... | ... | ... | |
| 75 | 26 ... | eP | 9 | 26 | 54 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 9 | 29 | 00 | ... | ... | ... | ... | ... | |
| 76 | December 4 ... | eP | 5 | 25 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 5 | 32 | 06 | ... | ... | ... | ... | ... | |
| 77 | 4 ... | eP | 23 | 38 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 23 | 46 | 18 | ... | ... | ... | ... | ... | |
| 78 | 5 ... | eP | 10 | 50 | 18 | ... | ... | ... | ... | ... | |
| | | eL | 10 | 51 | 36 | ... | ... | ... | ... | ... | |
| | | M | 10 | 56 | 00 | ... | ... | 60 | ... | ... | |
| | | F | 11 | 18 | 00 | ... | ... | ... | ... | ... | |
| 79 | 7 ... | eP | 21 | 38 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 21 | 46 | 12 | | ... | ... | ... | ... | |
| 80 | 10 ... | eP | 5 | 15 | 42 | ... | ... | ... | ... | ... | |
| | | eL | 5 | 38 | 18 | ... | ... | ... | ... | ... | |
| | | M | 5 | 45 | 54 | ... | ... | 310 | ... | ... | |
| | | F | 6 | 50 | 06 | ... | ... | ... | ... | ... | |
| 81 | 16 ... | eP | 12 | 13 | 06 | ... | ... | ... | ... | ... | |
| | | eL | 12 | 16 | 36 | ... | ... | ... | ... | ... | |
| | | M | 12 | 34 | 06 | ... | ... | 1500 | ... | ... | The boom struck the stops. |
| | | F | 16 | 25 | 24 | ... | ... | ... | ... | ... | |
| 82 | 17 .. | eP | 20 | 16 | 12 | ... | ... | ... | ... | ... | |
| | | eL | 20 | 19 | 42 | ... | ... | ... | ... | ... | |
| | | M | 20 | 21 | 18 | ... | ... | 40 | ... | ... | |
| | | F | 20 | 51 | 30 | ... | ... | ... | ... | ... | |
| 83 | 18 ... | eP | 10 | 34 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 10 | 45 | 18 | ... | ... | ... | ... | ... | |
| 84 | 19 ... | eP | 20 | 50 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 20 | 59 | 24 | ... | ... | ... | ... | ... | |
| 85 | 25 ... | eP | 11 | 29 | 18 | ... | ... | ... | ... | ... | |
| | | eL | 11 | 45 | 12 | ... | ... | ... | ... | ... | |
| | | M | 11 | 59 | 18 | ... | ... | 140 | ... | ... | |
| | | F | 13 | 02 | 12 | ... | ... | ... | ... | ... | |

# APPENDIX II.

Latitude 10° 13′ 50″ N.

Longitude $5^h$ $9^m$ $52^s$ E.

Height of Barometer cistern above mean sea level 7688 feet.

MEAN Monthly and Annual Meteorological Results at the Kodaikanal Observatory in 1920.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily Range. | Dry Bulb Thermometer. Mean. | Dry Bulb Thermometer. Max. | Dry Bulb Thermometer. Min. | Dry Bulb Thermometer. Range. | Wet Bulb. Mean. | Wet Bulb. Min. | Tension of Vapour. By Simpson's Tables. | Relative Humidity. By Simpson's Tables. | Sun Max. in Vac. | Min. on Grass. | Wind. Daily Velocity | Wind. Mean Direction. | Wind. Mean Direction. | Rain. Amount. | Rain. Days. | Clear sky. | Bright sunshine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Inches. | ° | ° | ° | ° | ° | ° | Inches. | Cents. | ° | ° | Miles. | Points | Points. | Inches. | No. | Cents. | Hours. |
| January | 22·837 | 0·067 | 53·8 | 61·6 | 45·9 | 15·7 | 48·2 | 42·3 | 0·288 | 71 | 116·0 | 35·0 | 289 | 4 | N.E. | 8·77 | 6 | 59 | 230·1 |
| February | ·871 | ·062 | 56·8 | 67·8 | 45·8 | 22·0 | 48·1 | 40·9 | ·255 | 56 | 129·0 | 34·7 | 290 | 5 | N.E. by E. | 0·38 | 2 | 81 | 288·0 |
| March | ·846 | ·062 | 61·4 | 72·9 | 49·8 | 23·1 | 49·3 | 42·0 | ·237 | 45 | 135·8 | 38·8 | 292 | 4 | N.E. | 0·10 | 0 | 68 | 299·9 |
| April | ·823 | ·066 | 61·0 | 70·0 | 52·0 | 18·0 | 53·6 | 47·7 | ·348 | 68 | 133·8 | 43·9 | 244 | 9 | E. by E. | 6·35 | 10 | 42 | 217·5 |
| May | ·821 | ·059 | 62·2 | 70·0 | 54·5 | 15·5 | 55·2 | 50·1 | ·375 | 70 | 131·6 | 46·5 | 197 | 17 | S. by W. | 3·68 | 7 | 43 | 217·2 |
| June | ·766 | ·054 | 59·7 | 65·9 | 53·5 | 12·4 | 54·8 | 50·6 | ·393 | 80 | 123·3 | 48·1 | 300 | 22 | W.S.W. | 2·70 | 10 | 22 | 139·6 |
| July | ·771 | ·047 | 58·3 | 64·0 | 52·5 | 11·5 | 53·9 | 49·5 | ·381 | 81 | 119·1 | 47·8 | 364 | 24 | W. | 3·23 | 9 | 17 | 125·3 |
| August | ·791 | ·056 | 57·2 | 63·1 | 51·4 | 11·7 | 53·4 | 48·9 | ·379 | 83 | 121·8 | 46·0 | 255 | 25 | W. by N. | 6·52 | 11 | 22 | 121·4 |
| September | ·785 | ·068 | 57·9 | 63·7 | 52·1 | 11·6 | 54·7 | 50·5 | ·406 | 88 | 110·0 | 47·5 | 217 | 23 | W. by S. | 12·39 | 17 | 25 | 130·8 |
| October | ·815 | ·071 | 57·7 | 64·3 | 51·2 | 13·1 | 53·8 | 49·6 | ·385 | 83 | 121·7 | 45·3 | 255 | 18 | S.S.W. | 5·24 | 12 | 31 | 163·8 |
| November | ·803 | ·069 | 55·2 | 59·4 | 51·1 | 8·3 | 53·3 | 50·1 | ·398 | 94 | 99·7 | 47·7 | 273 | 17 | S. by W. | 15·52 | 22 | 10 | 59·2 |
| December | ·829 | ·059 | 56·0 | 65·0 | 47·1 | 17·9 | 46·6 | 39·2 | ·230 | 52 | 120·7 | 34·9 | 196 | 15 | S. by E. | 0·58 | 3 | 68 | 264·7 |
| Annual | 22·813 | 0·062 | 58·1 | 65·6 | 50·6 | 15·1 | 52·1 | 46·8 | 0·340 | 73 | 121·9 | 43·0 | 264 | 18 | S.S.W. | 65·46 | 109 | 41 | 2257·5 |

EXTREME Monthly Meteorological Records at the Kodaikanal Observatory in 1920.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry Bulb Thermometer. Highest. | | Dry Bulb Thermometer. Lowest. | | Wet Bulb. Lowest. | | Humidity. Lowest. | | Sun Th. in Vacuo. Highest. | | Grass Therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest Fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Day. | Inches. | Day. | Inches. | ° | Day. | ° | Day. | ° | Day. | Cents. | Day. | ° | Day. | ° | Day. | Miles. | Day. | Miles. | Day. | Inches. | Day. |
| January | **22·946** | **8** | 22·755 | 1 | 0·191 | 67·7 | 26 | 40·3 | 23 | 33·4 | 31 | **7** | **18** | 135·0 | 25 | 24·7 | 31 | **722** | **3** | 123 | 18 | **3·03** | **2** |
| February | ·936 | 19 | ·788 | 28 | ·148 | 73·2 | 29 | 42·1 | 27 | 32·0 | 27 | 8 | 28 | 136·2 | 16 | 28·7 | 28 | 489 | 25 | 120 | 3 | 0·22 | 3 |
| March | ·937 | 6 | ·759 | 27 | ·178 | 75·3 | 31 | 44·2 | 1 | 34·9 | 1 | **7** | **25** | 147·1 | 10 | 29·1 | 1 | 427 | 16 | 169 | 22 | 0·08 | 16 |
| April | ·891 | 4 | ·747 | 27 | ·144 | 74·7 | 7 | 48·7 | 3 | 39·4 | 7 | 23 | 7 | **148·9** | **4** | 34·3 | 3 | 400 | 15 | 154 | 10 | 1·40 | 18 |
| May | ·907 | 9, 17 | ·711 | 1 | ·196 | **75·5** | **8** | 50·2 | 27 | 45·2 | 5 | 29 | 6 | 142·9 | 8 | 42·0 | 12 | 370 | 3 | 121 | 16 | 1·59 | 27 |
| June | ·842 | 28 | ·697 | 12, 20 | ·145 | 72·4 | 7, 10 | 50·6 | 30 | 47·2 | 9 | 52 | 6 | 141·0 | 7 | 42·4 | 14 | 469 | 30 | 140 | 27 | 0·80 | 28 |
| July | ·840 | 19 | ·677 | 23 | ·163 | 68·1 | 21 | 50·3 | 22 | 43·9 | 11 | 52 | 22 | 146·9 | 5 | 43·2 | 6 | 481 | 24 | 178 | 28 | 0·60 | 28 |
| August | ·862 | 31 | ·708 | 25 | ·154 | 66·4 | 27 | 49·6 | 13, 27 | 44·2 | 28 | 58 | 27 | 135·1 | 21 | 40·5 | 28 | 506 | 23 | 130 | 29 | 1·82 | 11 |
| September | ·864 | 18, 21 | ·711 | 7 | ·153 | 66·6 | 26 | 48·8 | 9 | 46·0 | 9 | 70 | 25, 29 | 133·5 | 25 | 43·8 | 10 | 490 | 7 | 102 | 15 | 2·12 | 16 |
| October | ·920 | 13 | **·671** | **5** | ·249 | 69·0 | 23 | 48·1 | 23 | 44·9 | 17 | 41 | 11, 12 | 142·0 | 23 | 38·3 | 17 | 435 | 27 | 117 | 31 | 0·97 | 3 |
| November | ·892 | 9 | ·695 | 22 | ·197 | 66·4 | 7 | 49·1 | 19 | 42·2 | 7 | 51 | 7 | 131·9 | 8 | 42·4 | 6 | 495 | 22 | 105 | 9 | 1·95 | 18 |
| December | ·906 | 19 | ·752 | 8 | ·154 | 70·3 | 10 | **39·6** | **23** | **31·5** | **4** | 8 | 4 | 129·7 | 19 | **24·1** | **28** | 370 | 11 | **75** | **24** | 0·28 | 18 |

# APPENDIX III.

KODAIKANAL mean hourly wind velocity for the year 1920.

| Month. | Hours. | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| January | 13 | 13 | 13 | 12 | 12 | 13 | 13 | 12 | 13 | 14 | 14 | 13 | 12 | 11 | 11 | 11 | 10 | 10 | 10 | 11 | 12 | 12 | 12 | 12 |
| February | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 15 | 17 | 15 | 14 | 12 | 11 | 9 | 8 | 7 | 7 | 7 | 8 | 9 | 11 | 13 | 15 |
| March | 11 | 12 | 13 | 13 | 14 | 13 | 13 | 14 | 15 | 18 | 16 | 16 | 16 | 13 | 12 | 10 | 9 | 8 | 7 | 8 | 8 | 9 | 7 | 11 |
| April | 10 | 10 | 10 | 9 | 10 | 10 | 12 | 11 | 12 | 13 | 13 | 11 | 11 | 10 | 10 | 10 | 9 | 9 | 8 | 8 | 8 | 9 | 10 | 11 |
| May | 9 | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 8 | 9 | 10 | 9 | 9 | 8 | 9 | 8 | 8 | 7 | 8 | 8 | 9 | 9 | 9 | 9 |
| June | 14 | 14 | 14 | 13 | 13 | 13 | 12 | 12 | 12 | 12 | 12 | 11 | 10 | 10 | 11 | 11 | 12 | 13 | 13 | 14 | 14 | 13 | 14 | 13 |
| July | 17 | 17 | 17 | 17 | 16 | 17 | 16 | 14 | 14 | 14 | 13 | 13 | 13 | 12 | 13 | 14 | 14 | 14 | 16 | 17 | 16 | 17 | 17 | 16 |
| August | 13 | 13 | 13 | 13 | 13 | 12 | 12 | 10 | 9 | 8 | 9 | 10 | 8 | 8 | 9 | 8 | 8 | 9 | 11 | 11 | 12 | 11 | 13 | 12 |
| September | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 8 | 8 | 9 | 8 | 8 | 9 | 8 | 9 | 8 | 8 | 8 | 9 | 9 | 10 | 9 | 10 |
| October | 12 | 12 | 13 | 12 | 13 | 12 | 12 | 11 | 12 | 11 | 11 | 11 | 10 | 10 | 9 | 8 | 8 | 8 | 9 | 10 | 9 | 10 | 11 | 11 |
| November | 11 | 10 | 11 | 12 | 10 | 11 | 12 | 13 | 13 | 12 | 12 | 12 | 11 | 13 | 11 | 10 | 10 | 9 | 12 | 12 | 11 | 12 | 13 | 10 |
| December | 9 | 9 | 9 | 9 | 8 | 8 | 8 | 9 | 10 | 10 | 10 | 9 | 9 | 8 | 7 | 7 | 5 | 6 | 6 | 7 | 7 | 8 | 9 | 9 |
| Mean | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 11 | 12 | 12 | 12 | 11 | 11 | 10 | 10 | 10 | 9 | 9 | 10 | 10 | 10 | 11 | 11 | 12 |

## APPENDIX IV.

KODAIKANAL mean hourly bright sunshine for the year 1920.

| Month. | Hours. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6–7 | 7–8 | 8–9 | 9–10 | 10–11 | 11–12 | 12–13 | 13–14 | 14–15 | 15–16 | 16–17 | 17–18 |
| January | 0·42 | 0·85 | 0·94 | 0·92 | 0·85 | 0·86 | 0·71 | 0·75 | 0·66 | 0·72 | 0·61 | 0·16 |
| February | ·39 | ·97 | 1·00 | 1·00 | ·99 | ·95 | ·90 | ·85 | ·79 | ·78 | ·77 | ·54 |
| March | ·80 | ·91 | 0·95 | 0·98 | 1·00 | ·99 | ·92 | ·76 | ·63 | ·63 | ·64 | ·47 |
| April | ·28 | ·66 | ·81 | ·93 | 0·93 | ·86 | ·68 | ·60 | ·49 | ·52 | ·36 | ·14 |
| May | ·23 | ·81 | ·91 | ·94 | ·91 | ·77 | ·66 | ·56 | ·47 | ·35 | ·29 | ·09 |
| June | ·17 | ·46 | ·63 | ·68 | ·62 | ·63 | ·59 | ·50 | ·35 | ·28 | ·18 | ·07 |
| July | ·08 | ·37 | ·46 | ·57 | ·50 | ·55 | ·52 | ·37 | ·30 | ·29 | ·15 | ·03 |
| August | ·10 | ·41 | ·57 | ·63 | ·61 | ·47 | ·37 | ·31 | ·24 | ·16 | ·14 | ·04 |
| September | ·08 | ·53 | ·70 | ·77 | ·70 | ·57 | ·47 | ·33 | ·22 | ·19 | ·10 | ·02 |
| October | ·19 | ·54 | ·68 | ·74 | ·61 | ·57 | ·59 | ·46 | ·43 | ·31 | ·26 | ·08 |
| November | ·04 | ·33 | ·54 | ·61 | ·53 | ·49 | ·28 | ·31 | ·21 | ·08 | ·07 | ·00 |
| December | ·24 | ·79 | ·86 | ·91 | ·91 | ·89 | ·88 | ·87 | ·81 | ·77 | ·59 | ·01 |
| Mean | 0·25 | 0·64 | 0·75 | 0·81 | 0·76 | 0·72 | 0·63 | 0·56 | 0·47 | 0·42 | 0·35 | 0·14 |

## APPENDIX V.

NUMBER of days in each month on which the Nilgiris were visible in 1920.

| Month. | Very clear. | Visible. | Just visible. | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January | 1 | 10 | ... | 1 | 12 |
| February | .. | 7 | ... | ... | 7 |
| March | | 3 | ... | 1 | 4 |
| April | 6 | 1 | ... | 1 | 8 |
| May | 1 | 2 | 2 | ... | 5 |
| June | 1 | 8 | 1 | ... | 10 |
| July | ... | ... | ... | ... | . |
| August | 4 | 2 | ... | .. | 6 |
| September | 1 | 8 | ... | 1 | 10 |
| October | 3 | 6 | ... | 3 | 12 |
| November | 1 | 3 | ... | ... | 4 |
| December | 16 | 7 | 1 | ... | 24 |
| Total | 34 | 57 | 4 | 7 | 102 |

# APPENDIX VI.

## METEOROLOGICAL Means, Kodaikanal.

| Month. | Barometer. | | Dry bulb. | | | | Wet Bulb. | | Vapour tension. | Humidity. | Sun Max. | Grass Min. | Wind. | | Rain. | | Clear sky. | Bright sun-shine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reduced to 32° | Range. | Mean. | Max. | Min. | Range. | Mean. | Min. | | | | | Velocity. | Direction. | | | | |
| | Inches. | Inches. | ° | ° | ° | ° | ° | ° | Inches. | Cents. | ° | ° | Miles. | Points. | Inches. | Days. | Cents. | Hours. |
| January | 22·848 | 0·067 | 54·3 | 63·7 | 46·9 | 16·8 | 47·0 | 40·3 | 0·257 | 62 | 119·1 | 37·5 | 305 | 5 | 2·88 | 4 | 63 | 239·4 |
| February | ·855 | ·067 | 55·8 | 66·3 | 47·5 | 18·8 | 47·9 | 41·2 | ·263 | 59 | 126·5 | 37·9 | 278 | 4 | 1·41 | 2 | 67 | 237·6 |
| March | ·857 | ·067 | 58·7 | 69·2 | 50·5 | 18·7 | 49·6 | 43·0 | ·269 | 55 | 132·5 | 41·0 | 294 | 6 | 2·03 | 3 | 69 | 261·5 |
| April | ·837 | ·066 | 60·7 | 70·2 | 53·5 | 16·7 | 53·5 | 47·6 | ·343 | 66 | 134·7 | 45·3 | 256 | 6 | 4·30 | 7 | 56 | 229·1 |
| May | ·811 | ·066 | 60·9 | 69·3 | 54·6 | 14·7 | 55·2 | 50·2 | ·382 | 72 | 133·1 | 48·2 | 247 | 5 | 5·95 | 11 | 46 | 209·3 |
| June | ·763 | ·058 | 58·4 | 65·1 | 53·6 | 11·5 | 54·2 | 50·0 | ·383 | 79 | 126·3 | 49·0 | 364 | 25 | 4·01 | 10 | 27 | 130·4 |
| July | ·756 | ·055 | 57·0 | 63·1 | 52·5 | 10·6 | 53·6 | 49·7 | ·382 | 83 | 123·2 | 48·7 | 395 | 25 | 4·96 | 12 | 23 | 114·9 |
| August | ·773 | ·062 | 57·0 | 63·6 | 52·3 | 11·2 | 53·8 | 49·5 | ·387 | 84 | 124·8 | 48·0 | 313 | 26 | 7·01 | 13 | 27 | 133·0 |
| September | ·787 | ·070 | 57·1 | 63·8 | 52·2 | 11·6 | 54·0 | 49·6 | ·390 | 84 | 126·1 | 47·8 | 271 | 25 | 7·01 | 13 | 29 | 128·5 |
| October | ·811 | ·073 | 56·2 | 62·8 | 51·3 | 11·5 | 53·3 | 49·0 | ·357 | 85 | 122·0 | 46·4 | 251 | 30 | 9·92 | 16 | 30 | 138·7 |
| November | ·820 | ·069 | 54·5 | 61·3 | 49·3 | 12·0 | 51·7 | 47·0 | ·361 | 85 | 115·8 | 44·8 | 268 | 1 | 7·81 | 12 | 34 | 132·8 |
| December | ·831 | ·067 | 54·0 | 62·3 | 47·7 | 14·7 | 48·4 | 42·3 | ·289 | 70 | 115·5 | 42·5 | 293 | 5 | 4·60 | 7 | 50 | 197·2 |
| Annual | 22·812 | 0·066 | 57·0 | 65·1 | 51·0 | 14·1 | 51·8 | 46·6 | 0·339 | 74 | 125·0 | 44·8 | 295 | N | 61·89 | 110 | 43 | 2152·4 |
| Period of means. | 1900 January to 1920 December. | | 1899 May to 1920 April. | | | | 1900 January to 1920 December. | | | | 1899 May to 1920 April. | 1900 January to 1920 December. | 1899 May to 1920 April. | 1903 January to 1920 December. | 1899 May to 1920 April. | | | 1900 January to 1920 December. |

## APPENDIX VII.

MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1920.

| Abnormals of | January. | February. | March. | April. | May. | June. | July. | August. | September | October. | November. | December. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure ... ... ... | − 0·012 | − 0·003 | − 0·017 | + 0·006 | + 0·002 | − 0·014 | − 0·011 | + 0·013 | − 0·020 | − 0·008 | − 0·048 | − 0·014 | − 0·010 |
| Temperature of air ... ... ... ... ... | + 1·7 | + 2·5 | + 1·9 | + 0·6 | + 0·8 | + 1·6 | + 3·1 | + 1·7 | + 2·4 | + 1·2 | + 1·1 | + 0·3 | + 1·6 |
| Do. of evaporation ... ... ... | + 2·5 | + 2·4 | + 1·5 | + 0·6 | + 0·7 | + 0·9 | + 1·1 | + 0·2 | + 0·8 | + 1·3 | + 2·1 | − 1·2 | + 1·1 |
| Percentage of humidity ... ... ... ... | + 4 | Normal | − 1 | Normal | + 1 | − 1 | − 5 | − 5 | − 5 | + 1 | + 5 | − 6 | − 1 |
| Greatest solar heat in *vacuo* ... ... ... | + 7·5 | + 12·2 | + 12·7 | + 13·1 | + 8·3 | + 5·8 | + 8·9 | + 7·7 | + 14·1 | + 0·6 | − 4·4 | + 12·2 | + 8·2 |
| Maximum in shade ... ... ... ... | − 0·4 | + 1·4 | + 0·7 | + 0·1 | + 1·6 | + 1·9 | + 3·9 | + 1·6 | + 2·5 | + 0·5 | − 0·5 | + 1·0 | + 1·2 |
| Minimum in shade .. ... ... ... ... | + 2·4 | + 2·9 | + 1·6 | + 0·5 | + 0·1 | + 1·1 | + 2·1 | + 1·2 | + 1·7 | + 1·3 | + 1·9 | − 1·5 | + 1·2 |
| Do. on grass ... ... ... ... | + 4·3 | + 3·8 | + 2·2 | + 0·7 | + 0·6 | + 1·2 | + 3·0 | + 1·7 | + 2·4 | + 2·5 | + 3·5 | − 1·4 | + 2·1 |
| Rainfall in inches ... ... ... ... ... | + 4·77 | − 0·28 | − 0·39 | − 0·56 | 0·87 | − 1·50 | − 1·68 | − 2·47 | − 4·22 | + 10·47 | + 16·87 | − 5·27 | ... |
| Do. since January 1st ... ... ... | + 4·77 | + 4·49 | + 4·10 | + 3·54 | + 2·67 | + 1·17 | − 0·51 | − 2·98 | − 7·20 | + 3·27 | + 20·14 | + 14·86 | + 14·86 |
| General direction of wind ... ... ... ... | 1 point N. | 3 points S. | 1 point S. | Normal | Normal | 1 point S. | 1 point W. | 1 point W. | Normal | 3 points S. | 3 points E. | 2 points E. | 1 point S. |
| Daily velocity in miles ... ... ... ... | − 39 | − 46 | − 56 | − 95 | − 92 | − 78 | − 55 | − 60 | − 72 | − 49 | + 67 | − 105 | − 68 |
| Percentage of cloudy sky ... ... ... ... | + 2 | − 46 | − 3 | + 10 | − 1 | − 17 | + 4 | − 55 | − 1 | + 3 | + 11 | − 25 | − 3 |
| Do. of bright sunshine ... ... ... | − 8·3 | + 3·6 | − 1·5 | − 6·1 | − 5·5 | + 11·1 | − 6·7 | + 0·9 | + 2·4 | − 4·6 | − 15·5 | + 16·0 | − 4·9 |

+ means *above* normal ; − means *below* normal.

## APPENDIX VIII.

ABSTRACT of the Mean Meteorological Condition of Madras in the year 1920 compared with the average of past years.

| Mean values of | 1920. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure ... ... ... ... | 29·854 | 0·010 below. | 29·864 |
| Temperature of air ... ... ... ... ... ... | 82·7 | 1·6 above. | 81·1 |
| Do. of evaporation ... ... ... ... ... | 75·6 | 1·1 ,, | 74·5 |
| Percentage of humidity ... ... ... ... ... ... | 71 | 1 below. | 72 |
| Greatest solar heat in *vacuo* ... ... ... ... ... | 147·9 | 8·2 above. | 139·7 |
| Maximum in shade ... ... ... ... ... ... | 92·0 | 1·2 ,, | 90·8 |
| Minimum in shade ... ... ... ... ... ... | 75·9 | 1·2 ,, | 74·7 |
| Do. on grass ... ... ... ... ... ... | 74·0 | 2·1 ,, | 71·9 |
| Rainfall since January 1st on 78 days ... ... ... ... | 63·89 | 14·87 ,, | 49·02 |
| General direction of wind ... ... ... ... ... | S.E. by S. | 1 point S. | S.E. |
| Daily velocity in miles ... ... ... ... ... ... | 103 | 68 below. | 171 |
| Percentage of cloudy sky ... ... ... ... ... | 46 | 3 ,, | 49 |
| Do. of bright sunshine ... ... ... ... ... | 53·5 | 4·9 ,, | 58·4 |

DURATION and quantity of the wind from different points.

| From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North. | 54 | 215 | East. | 77 | 387 | South. | 179 | 1149 | West. | 190 | 1380 |
| N. by E. | 265 | 1549 | E. by S. | 190 | 760 | S. by W. | 198 | 808 | W. by N. | 185 | 1261 |
| N.N.E. | 360 | 1774 | E.S.E. | 151 | 668 | S.S.W. | 188 | 747 | W.N.W. | 157 | 1037 |
| N.E. by N. | 341 | 2250 | S.E. by E. | 483 | 2454 | S.W. by S. | 148 | 600 | N.W. by W. | 86 | 513 |
| N.E. | 175 | 1154 | S.E. | 524 | 3036 | S.W. | 139 | 740 | N.W. | 35 | 176 |
| N.E. by E. | 215 | 1280 | S.E. by S. | 641 | 4126 | S.W. by W. | 193 | 889 | N.W. by N. | 41 | 171 |
| E.N.E. | 183 | 862 | S.S.E. | 314 | 1911 | W.S.W. | 324 | 1748 | N.N.W. | 58 | 279 |
| E. by N. | 110 | 531 | S. by E. | 182 | 964 | W. by S. | 304 | 1900 | N. by W. | 100 | 586 |

There were 1994 calm hours during the year. The resultant corresponding to the above numbers is represented by a S.E. wind, blowing with a uniform daily velocity of 19 miles.

# APPENDIX IX.

Madras Observatory.—Number of hours of wind from each point in the year 1920.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 41 | 18 | 37 | 137 | 95 | 101 | 56 | 28 | 22 | 10 | ... | ... | ... | ... | ... | ... | ... | ... | .. | ... | ... | ... | ... | .. | ... | . | ... | ... | ... | ... | ... | ... | 199 |
| February | ... | 1 | 3 | 10 | 22 | 10 | 21 | 13 | 9 | 40 | 20 | 52 | 39 | 82 | 52 | 20 | 16 | 8 | 16 | 2 | 3 | 3 | .. | ... | ... | ... | .. | ... | ... | ... | ... | ... | 254 |
| March | ... | ... | ... | ... | .. | ... | ... | ... | ... | 26 | 22 | 80 | 118 | 138 | 22 | 21 | 47 | 16 | 14 | 7 | 6 | 2 | 1 | ... | .. | ... | . | ... | .. | ... | .. | ... | 224 |
| April | ... | ... | ... | ... | ... | ... | .. | ... | 2 | 15 | 33 | 131 | 134 | 85 | 41 | 14 | 15 | 15 | 8 | 15 | 3 | 6 | 6 | 3 | ... | ... | .. | ... | ... | ... | . | ... | 194 |
| May | 3 | ... | 4 | 1 | 2 | ... | 11 | 5 | 2 | 9 | 9 | 38 | 87 | 192 | 68 | 45 | 29 | 38 | 26 | 19 | 12 | 5 | 11 | 13 | 12 | 17 | 8 | 4 | 4 | 4 | 4 | 1 | 61 |
| June | .. | ... | 1 | .. | ... | 1 | ... | 1 | 1 | 1 | 2 | 33 | 80 | 72 | 51 | 22 | 28 | 19 | 12 | 15 | 55 | 46 | 42 | 52 | 71 | 38 | 8 | 4 | 6 | 1 | 2 | ... | 56 |
| July | 1 | ... | ... | ... | .. | ... | 1 | 1 | 1 | 4 | 6 | 10 | 3 | 6 | 23 | 22 | 19 | 17 | 17 | 24 | 30 | 54 | 173 | 133 | 72 | 41 | 29 | 6 | ... | 4 | ... | ... | 47 |
| August | ... | 4 | 3 | 1 | 1 | .. | 2 | 1 | 3 | 14 | 17 | 57 | 16 | 31 | 34 | 16 | 7 | 40 | 54 | 31 | 13 | 40 | 51 | 59 | 21 | 52 | 57 | 34 | 8 | 8 | 5 | 4 | 60 |
| September | 4 | 8 | 5 | 1 | 1 | 5 | 7 | 8 | 5 | 15 | 18 | 41 | 18 | 23 | 9 | 7 | 9 | 21 | 32 | 20 | 13 | 28 | 28 | 31 | 11 | 33 | 45 | 35 | 12 | 14 | 17 | 14 | 182 |
| October | 2 | 54 | 43 | 45 | 11 | 25 | 13 | 13 | 5 | 20 | 12 | 39 | 25 | 10 | 6 | 14 | 8 | 21 | 9 | 14 | 4 | 8 | 11 | 13 | 2 | 4 | 9 | 3 | 5 | 10 | 30 | 21 | 235 |
| November | 3 | 96 | 115 | 72 | 16 | 47 | 62 | 21 | 7 | 22 | 7 | 1 | ... | 1 | .. | ... | ... | ... | ... | 1 | ... | 1 | 1 | ... | 1 | ... | 1 | ... | ... | ... | ... | 60 | 185 |
| December | ... | 84 | 149 | 74 | 27 | 26 | 10 | 19 | 20 | 14 | 5 | 1 | 4 | 1 | 8 | 1 | 1 | 3 | .. | ... | ... | ... | ... | ... | ... | . | ... | ... | .. | .. | ... | ... | 297 |
| Annual total | 54 | 265 | 360 | 341 | 175 | 215 | 183 | 110 | 77 | 190 | 151 | 483 | 524 | 641 | 314 | 182 | 179 | 198 | 188 | 148 | 139 | 193 | 324 | 304 | 190 | 185 | 157 | 86 | 35 | 41 | 58 | 100 | 1994 |

Madras Observatory.—Number of miles of wind from each point in the year 1920.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 125 | 260 | 186 | 808 | 711 | 539 | 256 | 183 | 113 | 24 | ... | ... | . | ... | ... | ... | ... | ... | ... | ... | .. | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3255 |
| February | ... | 5 | 8 | 56 | 113 | 49 | 117 | 43 | 46 | 166 | 66 | 217 | 136 | 439 | 356 | 101 | 94 | 50 | 90 | 19 | 15 | 8 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2194 |
| March | ... | ... | ... | ... | ... | ... | ... | ... | ... | 77 | 91 | 396 | 684 | 823 | 104 | 113 | 430 | 96 | 93 | 19 | 35 | 5 | 4 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2970 |
| April | .. | ... | ... | ... | ... | ... | ... | ... | 9 | 57 | 156 | 649 | 894 | 577 | 152 | 60 | 88 | 68 | 44 | 62 | 10 | 29 | 21 | 9 | ... | ... | ... | ... | ... | ... | ... | ... | 2885 |
| May | 36 | ... | 12 | 8 | 12 | ... | 27 | 29 | 16 | 47 | 51 | 187 | 537 | 1378 | 467 | 294 | 168 | 182 | 128 | 77 | 58 | 29 | 45 | 71 | 84 | 128 | 43 | 19 | 18 | 15 | 15 | 4 | 4185 |
| June | ... | ... | 6 | ... | ... | 6 | ... | 3 | 9 | 10 | 15 | 234 | 506 | 565 | 400 | 122 | 161 | 75 | 46 | 66 | 341 | 228 | 256 | 366 | 486 | 250 | 58 | 13 | 26 | 3 | 11 | ... | 4262 |
| July | 5 | ... | ... | ... | ... | ... | 5 | 5 | 1 | 20 | 22 | 65 | 23 | 43 | 128 | 101 | 97 | 55 | 59 | 105 | 151 | 308 | 1023 | 1003 | 605 | 348 | 183 | 47 | ... | 21 | ... | ... | 4423 |
| August | ... | 19 | 10 | 5 | 6 | ... | 14 | 6 | 20 | 106 | 106 | 320 | 81 | 145 | 230 | 86 | 45 | 142 | 177 | 108 | 63 | 169 | 227 | 267 | 156 | 327 | 369 | 180 | 49 | 39 | 28 | 27 | 3527 |
| September | 20 | 25 | 10 | 7 | 3 | 28 | 28 | 36 | 16 | 53 | 68 | 200 | 82 | 107 | 30 | 28 | 27 | 79 | 74 | 81 | 51 | 84 | 131 | 144 | 43 | 190 | 355 | 245 | 73 | 65 | 73 | 74 | 2530 |
| October | 8 | 240 | 175 | 280 | 73 | 166 | 74 | 75 | 33 | 52 | 60 | 183 | 88 | 41 | 28 | 57 | 36 | 57 | 36 | 60 | 16 | 26 | 36 | 40 | 5 | 18 | 28 | 9 | 10 | 28 | 152 | 112 | 2302 |
| November | 21 | 555 | 646 | 437 | 101 | 269 | 293 | 82 | 46 | 94 | 17 | 1 | ... | 7 | ... | ... | ... | ... | ... | 3 | .. | 3 | 5 | ... | 1 | ... | 1 | ... | .. | .. | ... | 369 | 2951 |
| December | ... | 445 | 721 | 649 | 135 | 173 | 48 | 69 | 78 | 54 | 16 | 2 | 5 | 1 | 16 | 2 | 3 | 4 | ... | ... | ... | .. | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2421 |
| Annual | 215 | 1549 | 1774 | 2250 | 1154 | 1280 | 862 | 531 | 387 | 760 | 668 | 2454 | 3036 | 4126 | 1911 | 964 | 1149 | 808 | 747 | 600 | 740 | 889 | 1748 | 1900 | 1380 | 1261 | 1037 | 513 | 176 | 171 | 279 | 586 | 37905 |

# APPENDIX XI.

MADRAS OBSERVATORY.—Number of inches of rain from each point in the year 1920.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 0·02 | ... | ... | ... | 2·10 | 0·72 | 0·09 | 2·19 | 0·10 | 0·44 | . | . | ... | ... | ... | ... | ... | ... | ... | ... | ... | .. | | .. | ... | ... | ... | ... | ... | ... | ... | .. | ... |
| February | ... | ... | .. | .. | .. | ... | ... | ... | ... | .. | .. | ... | ... | ... | ... | ... | ... | ... | .. | | . | ... | ... | .. | .. | ... | ... | ... | ... | ... | ... | ... | ... |
| March | ... | ... | .. | .. | ... | ... | ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... | .. | ... | ... | ... | ... | .. | ... | ... | ... | ... | | | ... | ... | ... | ... |
| April | ... | .. | .. | .. | ... | ... | ... | .. | ... | .. | . | 0·06 | ... | .. | . | . | ... | ... | .. | ... | ... | ... | ... | .. | ... | ... | ... | .. | . | ... | ... | ... | . |
| May | 0·84 | ... | ... | .. | ... | ... | ... | .. | ... | ... | ... | ... | ... | ... | 0·22 | . | ... | .. | . | .. | ... | ... | ... | ... | ... | 0·08 | ... | ... | 0·11 | .. | ... | ... | . |
| June | ... | ... | .. | ... | .. | .. | ... | | ... | ... | ... | ... | ... | .. | 0·03 | 0·09 | 0·02 | ... | 0·06 | ... | 0·05 | ... | ... | 0·15 | ... | 0·01 | 0·02 | . | .. | 0·02 | 0·10 | .. | 0·06 |
| July | .. | . | ... | .. | ... | . | ... | ... | ... | ... | 0·04 | ... | ... | ... | 0·14 | ... | 0·21 | 0·17 | 0·47 | 0·14 | 0·05 | 0·23 | 0·02 | 0·05 | 0·32 | ... | 0·13 | .. | ... | 0·19 | ... | ... | 0·03 |
| August | ... | ... | ... | ... | ... | .. | .. | ... | ... | .. | ... | ... | . | ... | ... | .. | ... | 0·01 | 0·17 | 0·10 | 0·48 | 0·25 | 0·18 | 0·14 | 0·38 | 0·12 | 0·02 | 0·03 | 0·17 | 0·04 | | ... | ... |
| September | ... | 0·11 | 0·01 | ... | ... | ... | ... | ... | ... | .. | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·07 | ... | 0·14 | 0·02 | . | ... | ... | .. | ... | ... | . | ... | ... | 0·12 |
| October | ... | 3·57 | 0·75 | 1·27 | 0·02 | 0·51 | .. | 2·24 | 0·09 | 0·50 | 0·06 | ... | ... | ... | ... | ... | ... | 0·12 | 0·01 | 0·01 | ... | ... | 0·21 | 0·53 | ... | .. | ... | ... | . | 1·70 | 3·52 | 3·24 | 3·12 |
| November | 0·46 | 4·24 | 8·11 | 2·10 | 0·77 | 1·40 | 7·15 | 1·06 | 0·86 | 1·71 | 0·63 | ... | ... | ... | ... | . | .. | ... | .. | ... | ... | ... | ... | ... | ... | ... | .. | .. | ... | ... | . | 0·78 | 0·81 |
| December | ... | | ... | | . | ... | | ... | 0·01 | ... | ... | ... | .. | ... | ... | | ... | ... | .. | ... | ... | ... | .. | ... | ... | ... | ... | . | ... | . | ... | .. | ... |
| Annual | 1·32 | 7·92 | 8·87 | 3·37 | 2·89 | 2·63 | 7·24 | 5·49 | 1·06 | 2·65 | 0·73 | 0·06 | ... | .. | 0·39 | 0·09 | 0·23 | 0·30 | 0·71 | 0·32 | 0·58 | 0·62 | 0·43 | 0·87 | 0·70 | 0·21 | 0·17 | 0·03 | 0·28 | 1·95 | 3·62 | 4·02 | 4·14 |

# APPENDIX XII.

MADRAS OBSERVATORY.—Wind, cloud and bright sunshine, 1920.

| Month. | Wind resultant. | | Cloud (0—10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H. | 16 H. | 20 H. | Mean. | Average per day. | Greatest number of hours in a day. |
| | MILES. | POINTS. | | | | | | HOURS. | HOURS. |
| January | 98 | N.E. | 4·1 | 4·6 | 4·3 | 2·5 | 3·9 | 6·8 | 9·5 |
| February | 56 | S.E. | 1·4 | 2·9 | 0·5 | 0·5 | 1·3 | 9·4 | 10·7 |
| March | 87 | S.E. by S. | 2·1 | 3·6 | 1·6 | 1·0 | 2·1 | 8·7 | 10·5 |
| April | 87 | S.E. | 4·7 | 4·7 | 3·6 | 2·3 | 3·8 | 7·9 | 11·1 |
| May | 97 | E.S.E. | 3·2 | 3·3 | 3·9 | 4·4 | 3·7 | 7·0 | 9·5 |
| June | 78 | S S.W. | 4·1 | 4·2 | 5·1 | 5·3 | 4·7 | 6·5 | 9·6 |
| July | 115 | W.S.W. | 6·5 | 6·5 | 8·5 | 8·5 | 7·5 | 4·1 | 8·6 |
| August | 47 | S.W. | 6·6 | 5·7 | 6·9 | 5·7 | 6·2 | 5·0 | 9·7 |
| September | 28 | W. by S. | 6·1 | 6·3 | 6·6 | 5·1 | 6·1 | 5·3 | 9·9 |
| October | 29 | N.E. | 6·8 | 7·1 | 5·5 | 5·2 | 6·2 | 5·4 | 10·5 |
| November | 86 | N.E. by N. | 7·4 | 8·0 | 6·8 | 5·5 | 7·0 | 3·7 | 10·0 |
| December | 68 | N.E. by N. | 2·9 | 4·2 | 1·9 | 1·6 | 2·7 | 7·8 | 9·3 |
| Annual | 19 | S.E. | 4·7 | 5·1 | 4·6 | 4·0 | 4·6 | 6·5 | ... |

# APPENDIX XIII.

MEAN Monthly and Annual Meteorological Results at the Madras Observatory in 1920.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily Range. | Dry Bulb Thermometer. Mean. | Dry Bulb Thermometer. Max. | Dry Bulb Thermometer. Min. | Dry Bulb Thermometer. Range. | Wet Bulb. Mean. | Wet Bulb. Min. | Tension of Vapour. By Simpson's Tables. | Relative Humidity. By Simpson's Tables. | Sun Max. in Vac. | Min. on Grass. | Wind. Daily Velocity. | Wind. Mean Direction. | Wind. Mean Direction. | Rain. Amount. | Rain. Days. | Cloudy sky. | Bright sunshine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Inches. | ° | ° | ° | ° | - | ° | Inches. | Cents. | ° | ° | Miles. | Points | Points. | Inches. | No. | Cents. | Hours. |
| January | 29·985 | 0·109 | 76·8 | 84·2 | 69·9 | 14·3 | 71·7 | 68·5 | 0·711 | 77 | 145·9 | 67·4 | 105 | 4 | N.E. | 5·66 | 6 | 39 | 211·4 |
| February | ·961 | ·127 | 79·2 | 88·0 | 70·9 | 17·1 | 73·2 | 69·7 | ·734 | 73 | 151·9 | 67·6 | 76 | 11 | S.E. by E. | . | . | 13 | 273·2 |
| March | ·886 | ·125 | 81·9 | 89·9 | 73·7 | 16·2 | 75·4 | 72·4 | ·793 | 73 | 153·2 | 70·8 | 96 | 13 | S E. by S. | ... | . | 21 | 269·2 |
| April | ·832 | ·124 | 84·6 | 93·0 | 77·7 | 15·3 | 78·2 | 75·8 | ·876 | 74 | 154·8 | 75·4 | 96 | 13 | S.E. by S. | 0·06 | 1 | 38 | 236·0 |
| May | ·737 | ·111 | 87·5 | 99·4 | 80·9 | 18·5 | 79·0 | 76·2 | ·875 | 68 | 151·3 | 79·5 | 135 | 15 | S. by E. | 1·25 | 3 | 37 | 216·1 |
| June | ·689 | ·117 | 88·0 | 100·2 | 81·4 | 18·8 | 77·5 | 74·4 | ·798 | 61 | 146·3 | 79·8 | 142 | 18 | S S.W. | 0·61 | 6 | 47 | 195·6 |
| July | ·710 | ·134 | 87·6 | 99·5 | 80·6 | 18·9 | 77·0 | 74·2 | ·785 | 60 | 147·6 | 79·6 | 143 | 21 | S W. by W. | 2·19 | 14 | 75 | 127·7 |
| August | ·762 | ·128 | 85·0 | 95·3 | 78·5 | 16·8 | 76·2 | 73·7 | ·781 | 65 | 147·7 | 77·1 | 114 | 20 | S.W. | 2·09 | 9 | 62 | 154·8 |
| September | ·759 | ·134 | 85·4 | 95·7 | 78·8 | 16·9 | 77·1 | 74·2 | ·817 | 67 | 155·4 | 77·4 | 84 | 18 | S.S W | 0·47 | 5 | 61 | 159·3 |
| October | ·839 | ·131 | 81·8 | 89·5 | 76·5 | 13·0 | 76·9 | 74·5 | ·858 | 79 | 139·7 | 75·3 | 74 | 10 | E.S.E. | 21·47 | 16 | 62 | 166·2 |
| November | ·877 | ·118 | 78·6 | 84·5 | 74·2 | 10·3 | 75·0 | 72·8 | ·821 | 84 | 133·0 | 73·0 | 98 | 5 | N.E. by E. | 30·08 | 17 | 70 | 110·9 |
| December | ·964 | ·108 | 75·8 | 84·6 | 68·3 | 16·3 | 69·4 | 66·2 | ·633 | 71 | 148·0 | 65·0 | 78 | 4 | N.E. | 0·01 | 1 | 27 | 241·8 |
| Annual | 29·833 | 0·122 | 82·7 | 92·0 | 75·9 | 16·0 | 75·6 | 72·7 | 0·790 | 71 | 147·9 | 74·0 | 103 | 13 | S E. by S. | 63·89 | 78 | 46 | 2362·2 |

EXTREME Monthly Meteorological Records at the Madras Observatory in 1920.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry Bulb Thermometer. Highest. | | Dry Bulb Thermometer. Lowest. | | Wet Bulb. Lowest. | | Humidity. Lowest. | | Sun Th. in Vacuo. Highest. | | Grass Therm. Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest Fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Day. | Inches. | Day. | Inches. | ° | Day. | ° | Day. | ° | Day. | Cents. | Day. | ° | Day. | ° | Day. | Miles. | Day. | Miles. | Day. | Inches. | Day. |
| January | **30·116** | **8** | 29·876 | 23 | 0·240 | 86·4 | 29 | 65·2 | 18 | 63·7 | 22 | 41 | 30 | 155·5 | 24 | 61·8 | 30 | **252** | **1** | 29 | 10 | 2·89 | 2 |
| February | ·110 | 25 | ·812 | 15 | ·298 | 91·8 | 29 | 66·6 | 24 | 65·7 | 24 | 38 | 29 | 159·7 | 8 | 62·4 | 24 | 165 | 16 | 26 | 21 | .. | ... |
| March | ·017 | 6 | ·712 | 30 | ·305 | 92·1 | 30 | 69·7 | 21 | 68·2 | 21 | 54 | 19 & 20 | 156·6 | 9 | 66·9 | 21 | 167 | 31 | 47 | 25 | . | ... |
| April | 29·948 | 3 | ·611 | 30 | ·337 | 97·8 | 24 | 74·3 | 15 | 72·3 | 15 | 51 | 9 | **167·7** | **19** | 71·9 | 15 | 148 | 25 | 44 | 29 | 0·06 | 19 |
| May | ·885 | 18 | ·565 | 3 & 4 | ·320 | **108·7** | **6** | 74·2 | 26 | 71·6 | 16 | 31 | 14 | 160·4 | 13 | 73·1 | 16 | 207 | 9 & 10 | 51 | 1 | 0·84 | 26 |
| June | ·817 | 29 | **·525** | **21** | ·292 | 106·1 | 6 | 75·1 | 28 & 29 | 71·9 | 6 & 7 | **28** | **23** | 155·6 | 23 | 73·1 | 28 | 219 | 21 | 28 | 23 | 0·22 | 28 |
| July | ·834 | 31 | ·528 | 23 | ·306 | 103·5 | 19 | 76·2 | 13 | 71·8 | 2 | 33 | 19 & 21 | 161·5 | 11 | 74·8 | 13 | 217 | 10 | 81 | 9 | 0·39 | 12 |
| August | ·875 | 3 | ·619 | 25 | ·256 | 101·1 | 28 | 74·6 | 2 | 71·4 | 27 | 29 | 26 | 166·6 | 31 | 73·1 | 1 | 161 | 27 | 36 | 15 | 1·15 | 1 |
| September | ·900 | 18 & 21 | ·590 | 7 | ·310 | 102·9 | 30 | 73·7 | 21 | 71·0 | 10 | 31 | 9 | 164·7 | 30 | 72·7 | 21 | 155 | 8 | 21 | 19 | 0·23 | 21 |
| October | 30·019 | 24 & 25 | ·629 | 5 | **·390** | 97·8 | 11 | 73·4 | 27 | 70·9 | 14 | 46 | 18 | 160·7 | 1 | 71·7 | 17 | 156 | 28 | **7** | **6** | **7·61** | **27** |
| November | ·007 | 13 | ·760 | 27 | ·247 | 92·3 | 9 | 69·4 | 30 | 68·3 | 30 | 57 | 7 | 158·6 | 11 | 67·2 | 30 | 184 | 25 | 24 | 3 & 8 | 5·95 | 13 |
| December | ·068 | 29 | ·864 | 8 | ·204 | 86·4 | 29 | **62·8** | **4** | **60·5** | **4** | 45 | 2 | 154·5 | 18 | **58·8** | **4** | 150 | 14 | 8 | 4 | 0·01 | 24 |

# ANNUAL REPORT

OF THE

# DIRECTOR
# KODAIKANAL AND MADRAS OBSERVATORIES

## FOR 1921

MADRAS
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1922

# KODAIKANAL AND MADRAS OBSERVATORIES.

## REPORT FOR THE YEAR 1921.

## CONTENTS.

### I.—KODAIKANAL OBSERVATORY.



### II.—MADRAS OBSERVATORY.

# KODAIKANAL AND MADRAS OBSERVATORIES

## I.—REPORT OF THE KODAIKANAL OBSERVATORY FOR THE YEAR 1921.

*Staff.*—The staff of the Observatory on December 31, 1921, was as follows :—

| | |
|---|---|
| Director ... ... ... ... | J. Evershed, F.R.S. |
| Assistant Director ... ... ... | T. Royds, D.Sc. |
| Assistants ... ... ... ... | A. A. Narayana Ayyar, B.A.<br>P. R. Chidambara Ayyar, B.A.<br>S. S. Ramaswami Ayyangar, B.A.<br>S. Balasundaram Ayyar. |
| Recorders ... ... ... ... | L. N. Krishnaswami Ayyar.<br>R. Krishna Ayyar.<br>S. N. Krishna Ayyar. |
| Temporary Recorder ... ... | K. R. Viswanatha Ayyar. |

The subordinate staff consists of a book-binder, an assistant book-binder, a mechanic, six peons, one boy peon for the dark room and two lascars.

Dr. Royds was granted combined leave for one year and was absent from the Observatory from February 25, 1921.

The head peon who also acted as engine and dynamo attendant died on August 29, 1921, from pneumonia. The accommodation for such cases at the Kodaikanal Municipal Hospital is quite inadequate, and it is considered that the life of this valuable and efficient servant might have been saved with reasonably up-to-date arrangements and nursing.

2. *Buildings and grounds.*—The main building containing the office requires outside painting, but is otherwise in good repair. There has been great delay in installing a new pump by the Public Works Department and much difficulty is experienced in carting water for photographic purposes. Repairs to the long line of wire fencing have been satisfactorily completed and the Observatory grounds have been maintained in good order.

3. *Instruments.*—With the exception of a new and very powerful prism spectrograph installed during the year in the spectroheliograph building the equipment remains essentially as in previous years. In December, the 12-inch photovisual lens was taken down and replaced by a 9-inch "skew Cassegrain" reflector for the spectroheliograph work, the lens being required for photographing star fields in preparation for the eclipse of September 1922.

The 30° reflecting prism mentioned in the last report has been thoroughly tested, alone and in combination with two 45° prisms of 6-inch aperture. Owing to want of homogeneity in the glass none of these large prisms can be used for the H$\alpha$ spectroheliograph.

4. *Weather conditions.*—Notwithstanding the very heavy rainfall in certain months of the year, the general conditions for solar work, as judged by the quality of the "seeing" and the number of days in which observations were possible, were on the whole more favourable than in the previous year. The mean definition in the north dome before 10 a.m. was 3·1 on a scale in which 1 is the worst and 5 the best, while the number of days in which the definition was 4 or over was 66. The

month of November, in which the observing conditions are usually very unfavourable, had the best mean definition, viz., 3·5, with a definition of 4 on fourteen days.

5. *Photoheliograph.*—Photographs on a scale of 8 inches to the Sun's diameter were taken on 339 days, using the 6-inch visual achromatic object glass and a green colour screen.

6. *Spectroheliographs.*—Monochromatic images of the Sun's disc in K light were obtained on 335 days, prominence plates on 279 days and H*a* disc plates on 285 days.

7. *Six-inch Cooke equatorial and spectroscope.*—Work with this instrument has been continued on the same lines as formerly for visual observations of solar phenomena which cannot be readily photographed.

8. *Grating spectrograph.*—Photographs of solar spectra with iron arc comparison have been obtained in the following spectral regions:—

| | | |
|---|---|---|
| 3870—3980 | ... ... ... ... ... | 28 plates. |
| 4325—4500 | ... ... ... ... ... | 33 „ |
| 6136—6252 | ... ... ... ... ... | 22 „ |

In each region the plates include spectra of the polar and equatorial limbs and the centre of the disc, and in the 4325—4500 region they include seven plates of general sunlight.

The results of the measures indicate a systematic difference in the sun – arc displacement between the north and south limbs, and this increases with the wave-length as is shown in the table following:

| Region. | Number of lines. | Mean shift sun – arc in angstroms. | | |
|---|---|---|---|---|
| | | North limb. | South limb. | S – N. |
| 3870—3980 ... ... ... ... | 24 | + ·0092 | + ·0102 | + ·0010 |
| 4325—4500 ... ... ... ... | 15 | + ·0075 | + ·0100 | + ·0025 |
| 6136—6252 ... ... ... ... | 5 | + ·0139 | + ·0176 | + ·0037 |

The east and west limb measures show a closer agreement with the south limb shifts than with the north.

These results confirm the difference found in measuring the cyanogen bands in plates obtained in 1918, which gave a difference S – N of + ·0023 A (Kodaikanal Observatory Bulletin LXIV, 301). No instrumental cause can be assigned to account for these differences.

In order to determine the shifts at a comparatively high level in the reversing layer twenty-four plates of the D region were obtained, including as before the polar and equatorial limbs and the centre of the disc; the comparison spectrum being that of a carbon arc giving very narrow sodium absorption lines. The general results show that the D lines give extremely small displacements both at the centre and at the limbs, the Sun – arc displacement of $D_1$ averaging – 0·001 A at the limbs and – 0·004 A at the centre, and $D_2$ giving + 0·002 A at the limbs and the same at the centre. The differences south limb – north limb for the mean of $D_1$ and $D_2$ is + 0·0013 A.

The difference of shift for $D_1$ and $D_2$ shows that the separation of these lines in Sun and arc in air is different, the interval $D_1$ — $D_2$ being about 0·004 A larger in the arc than in the Sun. This is probably a pressure effect and appears to indicate a nearly zero pressure at the D level of absorption in the Sun, since according to the measures of the D lines in the *vacuum* arc by Datta the interval $D_1$ — $D_2$ is practically the same as in the Sun.

The absence of appreciable shift at the centre or limbs is difficult to reconcile with the Einstein hypothesis, unless it can be shown that

the D lines in the arc in air are subject to a pressure shift which for 3/4 atmosphere (the air pressure at Kodaikanal) almost compensates the Einstein shift of + 0·0125 A. According to Perot the magnesium lines also indicate a zero pressure in the Sun, and when the known pressure shifts of these lines are added to the Sun — arc shifts the sum closely approximates to the Einstein shift.

Solar wave-lengths have been determined on the international system for 15 iron lines in the region 4337—4494 in light from the centre of the Sun's disc, the limbs, and in general sunlight ; also for 23 iron lines in the region 3885—3977 for the centre of the disc and the limbs. The results have been communicated to the President of Commission 14 of the International Astronomical Union.

The work on general sunlight has been in continuous operation during four successive years with the same equipment, and reveals apparent changes in wave-length in the annual means for some solar lines (not subject to pole effect in the arc) amounting to 0·004 A at the most. Other lines are shown to remain constant within 0·0005 A.

Mr. Narayana Ayyar has taken an active part in this work.

9. *Venus spectra.*—Fifteen plates were obtained during the first three months of the year when Venus was an evening star, the angle Venus-Sun-Earth diminishing from 67° to 27°. The measures of 13 plates taken in 1920 December and 1921 January with a mean angle at the Sun of 71° give slightly smaller wave-lengths than the plates of direct sunlight in 14 out of 17 lines measured, the mean difference being 0·0017 A. The plates taken later when the angle at the Sun was small show no appreciable difference, and the values for individual lines are in close agreement with the normal values of the Sun — arc shifts.

With the planet a morning star 5 plates were obtained in June and July, the mean angle Venus-Sun-Earth being 43°, and in September 5 more plates when the angle had increased to 95°. In neither of these series do the mean wave-lengths differ from the normal by more than 0·001 A.

To photograph the planet's spectrum when the angle Venus-Sun-Earth had become large and the exposure time short an entirely new scheme was adopted. An autocollimating prism spectrograph of 8 feet focal length was built giving the same dispersion as the grating at 4466, with much greater economy in light. An enlarged image of Venus is thrown on the slit from an 18-inch parabolic mirror combined with a convex mirror arranged in the "skew Cassegrain" form advocated by Common in 1895. This gives an image 0·8 mm. in diameter when the planet subtends 10″ only, there is therefore no uncertainty about the proper illumination of the slit while exposing, the planet covering from 25 to 30 times the slit width.

With this equipment 13 excellent spectra were photographed in November and December, the angle Venus-Sun-Earth increasing from 134° on November 21 to 148° on December 15. A preliminary discussion of the measures of these plates indicates only a small difference of wave-length in the Venus spectra compared with direct sunlight, the mean shift Sun — arc of 30 lines measured being + 0·0036 A in direct sunlight and + 0·0024 A in Venus.

A detailed discussion of the results will be published when the whole series of control plates has been measured.

10. *Rotation of Venus.*—Two attempts have been made to detect rotation by the shift of the lines. According to Rodés a direct rotation will produce a residual shift towards violet when the planet is east of the Sun, and towards red when west, assuming that the definition is imperfect and the image of the planet cannot be maintained in a definite position on the slit during the exposure. Our measures during the 5 years 1917—1921 show distinct evidence of such an effect, but the residuals

are towards violet when the planet is west of the Sun, indicating therefore a retrograde rotation : the difference of wave-length between east and west apparitions increases from 0·0018 A near elongations to 0·0025 A when the angle Sun-Venus-Earth has diminished and lies between 71° and 34°.

According to the observations of Pickering the planet rotates on an axis which lies nearly in the orbit plane and in longitude 47° approximately, the period being 68 hours. If this is correct the poles would be seen on the limb of the planet on or about 1921 September 14, and the equator would lie nearly parallel to the terminator. Spectrum photographs on a scale of 2 angstroms to the mm. were obtained on September 8, 14, 18, 19, 20 and 25 with the slit approximately parallel to the terminator. No appreciable inclination of the lines is found on any of the plates, but this would amount to 7′ only at the greatest. The rotation speed on the equator would be 0·125 Km/sec. only, and the difference of wave-length between the two edges of the spectrum would be 0·004 A or 0·002 mm. on these plates. Unfortunately the definition of the planet was extremely bad throughout the month and the edges of the spectra are indefinite. It is not, therefore, considered that the plates could reveal this difference although the spectrum lines are perfectly defined.

*Summary of sunspot and prominence observations.*

11. *Sunspots.*—The following table shows the monthly numbers of new groups observed at Kodaikanal, and their distribution between the northern and the southern hemispheres. The mean daily numbers of spots visible are also given :—

| — | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New groups .. ... | 8 | 14 | 14 | 11 | 6 | 13 | 12 | 11 | 5 | 6 | 3 | 9 | 112 |
| North .. ... | 3 | 3 | 9 | 6 | 3 | 7 | 5 | 5 | 2 | 4 | 2 | 5 | 54 |
| South ... | 5 | 11 | 5 | 5 | 2 | 6 | 7 | 6 | 3 | 1 | 1 | 4 | 56 |
| Equator ... ... | ... | ... | . | .. | 1 | ... | ... | ... | . | 1 | ... | ... | 2 |
| Daily numbers ... | 2·1 | 2·2 | 2·3 | 2·5 | 1·1 | 2·0 | 2·4 | 1·6 | 1·2 | 1·3 | 1·3 | 1·5 | 1·8 |

There was again a decrease, amounting to about 20 per cent in the case of new groups, the decrease being slightly more marked in the northern hemisphere. The visible disc was free from spots on 47 days during the year.

The approximate mean latitude of the spots was 9°·8 in the northern hemisphere and 10°·3 in the southern.

A large group of spots, situated on the equator crossed the central meridian on May 14–15. Its spectrum was characterised by very violent disturbances throughout the period it was visible. In addition to the hydrogen and helium lines, the lines of sodium, magnesium and the enhanced lines of iron were seen to be brightly reversed over the umbra of the spot on May 19. The meridian passage of the group synchronised with the occurrence of a magnetic storm of very great intensity and unprecedented duration.

The number of bright reversals of the H*a* line in the vicinity of spots was 263, whilst the number of displacements observed near spots was 177, of which 137 were towards red. $D_3$ was observed as a dark line on 129 occasions.

12. *Prominences.*—The mean daily areas in square minutes of arc, derived from the photographic records are as follows :—

| | North. | South. | Total. |
|---|---|---|---|
| 1921—January to June ... ... | 1·92 | 2·70 | 4·62 |
| July to December . ... | 1·76 | 1·79 | 3·55 |

The mean numbers decreased from 14·7 in the first half of the year to 13·6 in the second.

The general distribution in latitude is similar in the two periods of six months, and differs somewhat from that obtaining in the previous year. Well marked zones of activity are shown at about 40° in the northern hemisphere and at about 25° and 55° in the south. The polar regions remained quiescent.

Metallic prominences were very much less frequent than in 1920 and all were in low latitudes in the sunspot zones.

Four hundred and eighty displacements of the hydrogen lines were observed, of which 260 were towards the red.

Prominences projected on the disc as absorption markings showed a large decrease compared with the previous year.

There was an excess of prominence area on the east limb during the second quarter of the year and on the west limb during other months, whilst H$\alpha$ absorption markings have reverted to an eastern excess for the whole year, the proportion east being 52·5 per cent of the whole in the case of areas and 51·6 per cent for numbers.

Mr. Chidambara Ayyar has brought out an interesting relationship between the heliographic latitude of the earth and prominence numbers east and west of the Sun's axis during the years 1904—1920. The results are published in Bulletin No. LXVII.

A special study of the distribution in longitude of H$\alpha$ markings for the years 1915—1920 was made by Mr. Narayana Ayyar to see if the progressive change in area of sunspots during their progress across the disc as found by Mrs. Maunder in the years 1889—1901 was indicated by the markings also. It is found that the maximum area occurs in longitudes 40° to 60° east and west of the meridian with a great reduction near the limbs. In the northern hemisphere which alone gives a marked excess of east over west there is a progressive change in the eastern excess which is greatest near the limb and least between 30° and 40° from the meridian. In the central zone between 30° and 0° there is practical equality or very slight western excess.

The monthly mean areas of the prominences have been worked out for the eight-year periods 1905—1912 and 1913—1920. The curve of mean area for the year is strikingly alike in both periods, showing a maximum in March with a secondary maximum in August and a minimum in September. The curve bears some resemblance to the curve of monthly frequencies of magnetic storms recorded at Kodaikanal during the years 1903—1921, which shows maxima in the same months and a marked depression in the curve in September.

13. *Magnetic observations.*—Continuous magnetograph records are obtained of declination, vertical force and horizontal force. Absolute observations for dip are made daily excepting Sundays, declination and horizontal force on three days per week alternately. All the records are made over to the Magnetic Survey office, Dehra Dun, and the results are published by the Survey annually.

Sixteen " Great " and 85 " Moderate " magnetic storms were registered during the year. The storm of May 13—22 was of longer duration than

any previously recorded, and there was considerable disturbance to the Indian telegraph service on May 14 and 15. This storm may be regarded as composed of several distinct storms, and that of May 14—15 appears to have formed one of a sequence recurring at 27 day intervals for 7 synodic rotations of the sun, beginning March 21 and ending September 29.

14. *Time.*—The error of the standard clock is usually determined by reference to the 16 hour signal from the Madras Observatory. This is rendered possible by the courtesy of the Telegraph Department which permits the Madras wire to be joined through to this Observatory. The signal is received with accuracy on most days, and all failures are at once reported to the Postmaster-General, Madras.

15. *Meteorology.*—Eye observations are made at $8^h$, $10^h$ and $16^h$ local mean time as in former years. The Richard thermograph (wet and dry bulb) and barograph, the Beckley anemograph and the sunshine recorder also continue in use. Cloud observations with the Nephoscope are made three times daily. Under instructions from the Director-General of Observatories, the preparation of normals of all meteorological data at Kodaikanal up to the end of 1920, was undertaken and was in progress at the end of the year.

*Pressure.*—The mean pressure for the year was 0·005 inches below normal. The monthly means show that it was below normal from January to March and from May to July, and above normal in September and November, the greatest defect being 0·024 inches in February and the greatest excess 0·034 inches in November. The highest pressure recorded was 22·920 inches on March 16 and the lowest 22·657 inches on July 6.

*Temperature.*—The mean temperature for the year was normal, and the mean maximum and mean minimum (dry and wet bulb) were not far from normal. The highest temperature recorded was $76^{\circ}{\cdot}5$ on May 9 and the lowest was $40^{\circ}{\cdot}3$ on February 26. The lowest minimum on grass was $27^{\circ}{\cdot}2$ on December 8.

*Humidity.*—The mean humidity for the year was 3 cents below normal. The greatest deviations were a defect of 16 cents in March and 15 in December. The driest day in the year was February 28 when the humidity fell to 3 cents.

*Rainfall.*—The distribution of rainfall was uneven throughout the year. The total rainfall was 77·52 inches or 15·63 inches above normal. The total rainfall in January was 13·58 inches against an average of 2·88 inches, whilst the month of November had a deficit of 4·11 inches. The heaviest rainfall recorded on any one day was 6·91 inches on January 14, which is also the heaviest ever recorded at the Observatory.

*Wind.*—The mean wind direction for the year differed from the normal by 10 points to the west. The air movement was below normal in April, May, July, August, October and November.

*Transparency of the atmosphere.*—The transparency of the lower atmosphere as judged by the visibility of the Nilgiris about 100 miles distant was much below the average.

*Cloud and sunshine.*—The percentage of clear sky was above normal in February, March and November, and below normal in January, April, July and October. During the other months it was normal. The total number of hours of bright sunshine was 2236 as against an average of 2152.

16. *Seismology.*—The Milne horizontal pendulum recorded 105 earthquakes as against 85 during the previous year. Details of the records are given in appendix I.

17. *Library.*—Seventy-six volumes were bound during the year.

18. *Publications.*—The annual report for the year 1920, and bulletins Nos. LXVI to LXVIII were published and distributed during the year. Their titles are given below :—

No. LXVI. Summary of prominence observations for the second half of the year 1920, by T. Royds, D.Sc.

No. LXVII. An apparent influence of the earth on solar prominences, by J. Evershed, F.R.S., and P. R. Chidambara Ayyar, B.A.

No. LXVIII. Summary of prominence observations for the first half of the year 1921, by J. Evershed, F.R.S.

In addition the Director has contributed the following paper : "The Relativity shift in the solar spectrum"—Observatory 44, 243.

KODAIKANAL,
*24th January* 1922.

J. EVERSHED,
*Director, Kodaikanal and Madras Observatories.*

## II.—REPORT OF THE MADRAS OBSERVATORY FOR THE YEAR 1921.

*Staff.*—The staff of the Observatory during the year 1921 was as follows :—

| | |
|---|---|
| Deputy Director ... ... ... ... | Edward Barnes, B.Sc. (January 1 to May 4). S. R. U. Savoor, B.A., D.Sc. (May 5 to December 31). |
| Time Assistant ... ... ... ... | C. P. Venkatarama Ayyar, M.A. (March 18 to December 31). |
| Observers ... ... ... ... ... | P. Jayaram Mudaliyar (January 1 to December 31). S. S. Ranga Acharya (January 1 to October 31). K. Viswanathan (November 1 to December 31). |

Since Mr. Solomon Pillai, the Time Assistant, retired from service on the 25th October 1920, the Observatory had to work understaffed till 18th March 1921, when Mr. C. P. Venkatarama Ayyar was appointed in the place. Mr. P. Jayaram Mudaliyar was absent on privilege leave from 20th May to 1st July and again from 1st November to 16th November. Mr. S. S. Ranga Acharya, having been deputed as Observer to the Humidification Expert to the Government of India, for one year from 1st November, Mr. K. Viswanathan was appointed acting Observer from that date.

2. *Time-service.*—The time gun at Fort St. George failed on 14 occasions out of 731, giving a percentage of success of 98. Most of the failures were due either to faults in the firing instrument at the Fort, which, owing to long use, has become much worn out, or to the mistakes on the line. The main line and the connections to the instrument therefrom require renewal. The gun was fired at 8 hrs. and 11 hrs. instead of at 12 hrs. on November 11, on account of the anniversary of the armistice. The time ball at the Harbour failed at 13 hrs. on one day, owing to the Observatory not being connected to the Signal Station till after 1–15 p.m., but it dropped correctly at 14 hrs. The 16 hr. roll of signals was sent as usual to the Central Telegraph Office.

The 7 p.m. Radio Signals were received for a few days now and then till the end of September when they ceased to arrive except on very rare occasions. The arrangement of receiving the signals over the Telephone seems to be quite unsatisfactory and arrangements are being made to supply this Observatory with a simple wireless receiving set. It is hoped that after the installation of this set, signals will be received satisfactorily so as to enable comparisons between Calcutta and Madras clocks to be made accurately.

3. *Meteorological observations.*—Eye observations were made daily at 8 hrs., 10 hrs., 16 hrs. and 20 hrs. local mean time as in former years and the records of self-registering instruments maintained as usual. Observations with Kata thermometer for the determination of the cooling power of air have been made since the beginning of this year. Extra observations were taken for storm warning purposes and telegrams sent to Calcutta on 17 occasions and to Simla on 11 occasions.

4. *Buildings.*—Though the usual annual repairs to the office and some special repairs to the quarters were carried out during the year, still there is much left to be done in this connection. The terraced roof of the

quarters, and the dome in which the equatorial is fitted up are still leaking badly and but for the scarcity of rain in November and December, it would have been extremely difficult to reside in the quarters.

5. *Instruments.*—The following is a list of instruments at the Observatory on 31st December 1921 :—

(*a*) *Astronomical.*

Eight-inch Equatorial Telescope—Troughton and Simms.
Sidereal clock—Haswall.
Do. Dent, No. 1408.
Do. S. Riefler, No. 61.
Mean Time clock—J. H. Agar Baugh, No. 105.
Do. with galvanometer—Shepherd & Sons.
Meridian circle—Troughton and Simms.
Portable transit instrument—Dollond.
Tape chronograph—R. Fuess.
Relay for use with the chronograph—Siemens.

(*b*) *Meteorological.*

Richard's barograph—No. 10, L. Casella.
Do. thermograph—No. 29637, L. Casella.
Peander's self-recording rain-gauge—No. 116, Lawrence and Mayo.
Beckley's anemograph—Adie.
Sunshine recorder—No. 149, L. Casella.
Nephoscope—Mons Jules Daboseq and Ph. Pellin.
Barometer, Fortin's—No. 1771, L. Casella.
Do. do. No. 725, L. Casella (spare).
Do. do. No. 1520, L. Casella (spare).
Dry bulb thermometer—No. 94221, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Wet bulb do. No. 94219, L. Casella.
Do. do. No. 38037, Negretti and Zambra (spare).
Dry maximum thermometer—No. 8581, Negretti and Zambra.
Dry minimum do. No. 54182, Casella.
Wet do. do. No. 91753, Negretti and Zambra.
Sun maximum do. No. 127618, Negretti and Zambra.
Grass minimum do. No. 3377, Negretti and Zambra.
Rain-gauge (8″ diameter)—No. 1042, Negretti and Zambra.
Measure glass for above.
Rain-gauge (5″ diameter).
Measure glass for above.
Stop watch—No. A·3.
Kata thermometer No. 273, J. Hicks & Co.

The Riefler clock, Kullberg's chronometer No. 5394 and Beckley's anemograph were all cleaned early this year, while during the visit of the Director from Kodaikanal in December, the Dent and the A.B. clocks were completely overhauled and cleaned. The level error of the Transit Circle at the beginning of the year was $-2^{s}\cdot67$. It changed gradually till it reached a maximum value of $-11^{s}\cdot36$ about the end of second week of October. As a result of continued heavy rains it went through a rapid change in the reverse direction. This continued till the end of first week of November when it remained fairly steady at about $-3^{s}\cdot60$ till the middle of December after which it again showed a slight rise.

The rate of the Riefler clock was not quite so steady as might be expected.

6. *Weather summary.*—The following is a summary of the meteorological conditions at Madras during 1921 :—

*Pressure.*—The mean monthly pressure was normal in April, August and September, above normal in October, November and December and below normal in the remaining months, the greatest excess being 0·060 inch in November and the greatest defect 0·075 inch in May. The highest pressure recorded was 30·124 inches on the 11th of December.

*Temperature.*—The mean temperature of the air was normal in February and April, below normal in July, October and November and above normal in the remaining months. The highest temperature recorded was 111°·2 on the 25th May. The minimum in shade was normal in March, August, September and October, below normal in February, July, November and December and above normal in the other months. The lowest temperature recorded was 63°·6 on the 10th November. The highest sun maximum was 168°·3 on the 9th of June and the lowest on grass was 59°·4 on the 10th of November.

*Humidity.*—The percentage of humidity was about normal throughout the year. The driest day in the year was the 26th May and the wettest the 16th of October.

*Wind.*—The wind velocity was in defect throughout the year. The wind direction was normal in January, June, September and December and very abnormal during October.

*Cloud.*—The amount of cloud was above normal in January, April, July and October and below normal in the other months. During November and the first half of December the sky was quite unusually less cloudy.

*Sunshine.*—The percentage of sunshine was normal in March and September, above normal in February, August and November and below normal in the other months. The total number of hours of bright sunshine during the year was 2189·5.

*Rainfall.*—The rainfall was above the average in January, April, July, August and October and below in the remaining months. The greatest excess was 13·27 inches in October and the greatest defect 11·37 inches in November. The total fall for the year was 54·43 inches on 96 days compared with an average of 49·02 inches. The monsoon rainfall from the 15th October to the end of the year was 20·81 inches. The heaviest rainfall on one day was 3·28 inches on 13th October.

*Storm.*—A severe storm formed in the Bay near Port Blair about the 5th of October giving very heavy rain there. It then gradually moved towards the east coast and then north west giving heavy rains on the north Madras coast. It filled up near Nellore about the 8th and then passed across the Peninsula into the Arabian Sea about the 9th. Another storm from near Port Blair moved south west to Ceylon about the 24th of the same month and then north, practically covering the whole of the east coast on the 25th and finally disappeared.

MADRAS,
14*th January* 1922.

S. R. U. SAVOOR,
*Deputy Director, Madras Observatory.*

# APPENDIX I.

## STATION—KODAIKANAL OBSERVATORY.

### SEISMIC RECORDS.

$\phi = 10° 13' 50''$ $\lambda = 77° 28' 00''$ $h = 2343$ metres. *Subsoil*—Rock.

*Apparatus*—Milne's Horizontal Pendulum Seismograph.

| 1921. | $T_o$ | $\frac{\tau}{T_o^2}$ | 1921. | $T_o$ | $\frac{\tau}{T_o^2}$ |
|---|---|---|---|---|---|
| January ... ... ... | 17·3 | 2·7 | July ... ... ... | 17·3 | 2·8 |
| February ... ... ... | 17·6 | 2·6 | August ... ... ... | 17·5 | 2·8 |
| March ... ... ... | 17·1 | 2·5 | September ... ... | 17·3 | 2·9 |
| April ... ... ... | 17·2 | 3·0 | October ... ... ... | 17·4 | 2·8 |
| May ... ... ... | 17·6 | 2·8 | November ... ... ... | 17·2 | 2·9 |
| June ... ... ... | 17·3 | 2·9 | December ... ... ... | 17·5 | 2·6 |

| No. | Date. | Phase. | Time G.M.T. | | | Period (Sec.). | Amplitude ($\mu$). | | | Distance $\Delta$ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | H. | M. | S. | | AN. | AE. | AZ. | | |
| | 1921. | | | | | | | | | | |
| 1 | January 3 ... | eP | 21 | 58 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 22 | 06 | 24 | ... | ... | ... | ... | ... | |
| 2 | 6 ... | eP | 2 | 35 | 54 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 2 | 41 | 18 | ... | ... | ... | ... | ... | |
| 3 | 6 ... | eP | 4 | 09 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 4 | 11 | 54 | ... | ... | ... | ... | ... | |
| 4 | 6 ... | eP | 4 | 31 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 4 | 36 | 42 | ... | ... | ... | ... | ... | |
| 5 | 6 ... | eP | 23 | 30 | 00 | ... | ... | ... | ... | ... | Widening of line. In continuation of hour mark. |
| | | F | 23 | 41 | 18 | ... | ... | ... | ... | ... | |
| 6 | 7 ... | eP | 1 | 55 | 36 | ... | ... | ... | ... | ... | |
| | | eL | 2 | 04 | 54 | ... | ... | ... | ... | ... | |
| | | M | 2 | 09 | 00 | ... | ... | 60 | ... | ... | |
| | | F | 2 | 23 | 18 | ... | ... | ... | ... | ... | |
| 7 | 7 ... | eP | 3 | 14 | 06 | ... | ... | ... | ... | ... | |
| | | eL | 3 | 26 | 24 | ... | ... | ... | ... | ... | |
| | | M | 3 | 36 | 12 | ... | ... | 50 | ... | ... | |
| | | F | 4 | 04 | 18 | ... | ... | ... | ... | ... | |
| 8 | 9 ... | eP | 14 | 11 | 54 | ... | ... | ... | ... | ... | |
| | | eL | 14 | 18 | 42 | ... | ... | ... | ... | ... | |
| | | M | 14 | 25 | 54 | ... | ... | 50 | ... | ... | |
| | | F | 15 | 24 | 24 | ... | ... | ... | ... | ... | |
| 9 | 19 ... | eP | 15 | 43 | 18 | ... | ... | ... | ... | ... | |
| | | eL | 15 | 46 | 24 | ... | ... | ... | ... | ... | |
| | | M | 15 | 48 | 30 | ... | ... | 40 | ... | ... | |
| | | F | 16 | 06 | 54 | ... | ... | ... | ... | ... | |
| 10 | 24 ... | eP | 11 | 26 | 24 | ... | ... | ... | ... | ... | |
| | | eL | 11 | 31 | 00 | ... | ... | ... | ... | ... | |
| | | M | 11 | 32 | 36 | ... | ... | 60 | ... | ... | |
| | | F | 11 | 43 | 48 | ... | ... | ... | ... | ... | |
| 11 | February 4 ... | eP | 8 | 50 | 36 | ... | ... | ... | ... | ... | |
| | | eL | 8 | 59 | 00 | ... | ... | ... | ... | ... | |
| | | M | 9 | 00 | 24 | ... | ... | 50 | ... | ... | |
| | | F | | ? | | ... | ... | ... | ... | ... | } Overlapping. |
| 12 | 4 ... | P | | ? | | ... | ... | ... | ... | ... | |
| | | eL | 9 | 55 | 36 | ... | ... | ... | ... | ... | |
| | | M | 9 | 59 | 42 | ... | ... | 60 | ... | ... | |
| | | F | 10 | 41 | 48 | ... | ... | ... | ... | ... | |
| 13 | 6 ... | eP | 4 | 49 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 4 | 51 | 30 | ... | ... | ... | ... | ... | |
| 14 | 6 .. | eP | 7 | 14 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 7 | 24 | 54 | ... | ... | ... | ... | ... | |
| 15 | 13 ... | eP | 21 | 51 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 21 | 57 | 42 | ... | ... | ... | ... | ... | |
| 16 | 14 ... | eP | 1 | 17 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 1 | 37 | 12 | ... | ... | ... | ... | ... | |
| 17 | 19 ... | eP | 14 | 51 | 30 | ... | ... | ... | ... | ... | |
| | | eL | 15 | 13 | 06 | ... | ... | ... | ... | ... | |
| | | M | 15 | 14 | 36 | ... | ... | 50 | ... | ... | |
| | | F | 15 | 28 | 36 | ... | ... | ... | ... | ... | |

| No. | Date. | | Phase. | Time G.M.T. H. | M. | S. | Period (Sec.). | Amplitude (μ). An. | Ae. | Az. | Distance △ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1921. | | | | | | | | | | | |
| 18 | February | 19 ... | eP | 18 | 25 | 18 | ... | ... | ... | ... | ... | |
| | | | eL | 18 | 37 | 24 | ... | ... | ... | ... | ... | |
| | | | $M_1$ | 18 | 39 | 30 | ... | ... | 70 | ... | ... | |
| | | | $M_2$ | 18 | 53 | 18 | ... | ... | 80 | ... | ... | |
| | | | F | 20 | 14 | 06 | ... | ... | ... | ... | ... | |
| 19 | | 21 ... | P | | ... | | ... | ... | ... | ... | ... | No P.Ts. |
| | | | iL | 2 | 08 | 00 | ... | ... | ... | ... | ... | |
| | | | M | 2 | 10 | 30 | ... | ... | 60 | ... | ... | |
| | | | F | 2 | 23 | 18 | ... | ... | ... | ... | ... | |
| 20 | | 28 ... | eP | 18 | 42 | 18 | ... | ... | ... | ... | ... | |
| | | | iL | 18 | 52 | 36 | ... | ... | ... | ... | ... | |
| | | | M | 18 | 53 | 48 | ... | ... | 140 | ... | ... | |
| | | | F | | ? | | ... | ... | ... | ... | ... | Overlapping. |
| 21 | | 28 ... | P | | ? | | ... | ... | ... | ... | ... | |
| | | | eL | 19 | 17 | 12 | ... | ... | ... | ... | ... | |
| | | | M | 19 | 40 | 18 | ... | ... | 260 | ... | ... | |
| | | | F | 21 | 27 | 24 | ... | ... | ... | ... | ... | |
| 22 | March | 3 ... | eP | 3 | 42 | 36 | ... | ... | ... | ... | ... | |
| | | | eL | 3 | 45 | 30 | ... | ... | ... | ... | ... | |
| | | | M | 3 | 48 | 24 | ... | ... | 50 | ... | ... | |
| | | | F | 3 | 55 | 48 | ... | ... | ... | ... | ... | |
| 23 | | 3 ... | eP | 8 | 33 | 54 | ... | ... | ... | ... | ... | |
| | | | eL | 8 | 35 | 42 | ... | ... | ... | ... | ... | |
| | | | M | 8 | 44 | 12 | ... | ... | 210 | ... | ... | |
| | | | F | 9 | 17 | 24 | ... | ... | ... | ... | ... | |
| 24 | | 5 ... | P | | ... | | ... | ... | ... | ... | ... | No P.Ts. |
| | | | iL | 6 | 32 | 30 | ... | ... | ... | ... | ... | |
| | | | M | 6 | 35 | 36 | ... | ... | 640 | ... | ... | |
| | | | F | 7 | 23 | 06 | ... | ... | ... | ... | ... | |
| 25 | | 19 ... | eP | 8 | 32 | 42 | ... | ... | ... | ... | ... | |
| | | | eL | 8 | 42 | 48 | ... | ... | ... | ... | ... | |
| | | | M | 8 | 45 | 06 | ... | ... | 30 | ... | ... | |
| | | | F | 9 | 01 | 24 | ... | ... | ... | ... | ... | |
| 26 | | 21 ... | eP | 5 | 38 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 5 | 46 | 00 | ... | ... | ... | ... | ... | |
| 27 | | 23 ... | eP | 22 | 57 | 00 | ... | ... | ... | ... | ... | |
| | | | eL | 23 | 14 | 00 | ... | ... | ... | ... | ... | |
| | | | M | 23 | 20 | 06 | ... | ... | 70 | ... | ... | |
| | | | F | 23 | 38 | 06 | ... | ... | ... | ... | ... | |
| 28 | | 24 ... | eP | 1 | 50 | 48 | ... | ... | ... | ... | ... | |
| | | | eL | 1 | 55 | 06 | ... | ... | ... | ... | ... | |
| | | | M | 1 | 58 | 00 | ... | ... | 50 | ... | ... | |
| | | | F | 2 | 19 | 12 | ... | ... | ... | ... | ... | |
| 29 | | 24 ... | eP | 10 | 15 | 06 | ... | ... | ... | ... | ... | |
| | | | eL | 10 | 20 | 42 | ... | ... | ... | ... | ... | |
| | | | M | 10 | 25 | 24 | ... | ... | 130 | ... | ... | |
| | | | F | 11 | 10 | 42 | ... | ... | ... | ... | ... | |
| 30 | | 24 ... | iP | 15 | 04 | 42 | ... | ... | ... | ... | ... | |
| | | | eL | 15 | 28 | 18 | ... | ... | ... | ... | ... | |
| | | | M | 15 | 44 | 48 | ... | ... | 60 | ... | ... | |
| | | | F | 16 | 06 | 36 | ... | ... | ... | ... | ... | |
| 31 | | 26 ... | P | | ... | | ... | ... | ... | ... | ... | No P.Ts. |
| | | | iL | 2 | 28 | 12 | ... | ... | ... | ... | ... | |
| | | | M | 2 | 31 | 00 | ... | ... | 130 | ... | ... | |
| | | | F | 2 | 43 | 18 | ... | ... | ... | ... | ... | |
| 32 | | 28 ... | eP | 8 | 12 | 18 | ... | ... | ... | ... | ... | |
| | | | eL | 8 | 28 | 12 | ... | ... | ... | ... | ... | |
| | | | M | 8 | 31 | 30? | ... | ... | 50? | ... | ... | M falls on the hour mark. |
| | | | F | | ? | | ... | ... | ... | ... | ... | Overlapping. |
| 33 | | 28 ... | P | | ? | | ... | ... | ... | ... | ... | |
| | | | eL | 9 | 13 | 06 | ... | ... | ... | ... | ... | |
| | | | M | 9 | 52 | 12 | ... | ... | 70 | ... | ... | |
| | | | F | 10 | 13 | 48 | ... | ... | ... | ... | ... | |
| 34 | | 29 ... | eP | 23 | 00 | 48 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 23 | 24 | 54 | ... | ... | ... | ... | ... | |
| 35 | | 30 ... | eP | 10 | 32 | 18 | ... | ... | ... | ... | ... | |
| | | | eL | 10 | 38 | 12 | ... | ... | ... | ... | ... | |
| | | | M | 10 | 47 | 12 | ... | ... | 30 | ... | ... | |
| | | | F | 10 | 56 | 24 | ... | ... | ... | ... | ... | |
| 36 | | 30 ... | eP | 15 | 10 | 48 | ... | ... | ... | ... | ... | |
| | | | eL | 15 | 21 | 30 | ... | ... | ... | ... | ... | |
| | | | M | 15 | 44 | 12 | ... | ... | 80 | ... | ... | |
| | | | F | 16 | 04 | 18 | ... | ... | ... | ... | ... | |
| 37 | April | 1 ... | iP | 4 | 11 | 30 | ... | ... | ... | ... | ... | |
| | | | iL | 4 | 15 | 36 | ... | ... | ... | ... | ... | |
| | | | M | 4 | 19 | 12 | ... | ... | 380 | ... | ... | |
| | | | F | 5 | 56 | 42 | ... | ... | ... | ... | ... | |

| No. | Date. | Phase. | Time G.M.T. H. | M. | S. | Period (Sec.). | Amplitude (μ). An. | Ae. | Az. | Distance Δ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1921. | | | | | | | | | | |
| 38 | April 2 ... | eP | 9 | 51 | 30 | ... | ... | ... | ... | ... | |
| | | eL | 10 | 02 | 18 | ... | ... | ... | ... | ... | |
| | | M | 10 | 14 | 24 | ... | ... | 120 | ... | ... | |
| | | F | 11 | 04 | 06 | ... | ... | ... | ... | ... | |
| 39 | 17 ... | eP | 22 | 28 | 12 | ... | ... | ... | ... | ... | Widening of line. Falls on the hour mark. |
| | | F | 22 | 34 | 54 | | | | | | |
| 40 | 25 ... | eP | 18 | 34 | 54 | ... | ... | ... | ... | ... | |
| | | eL | 18 | 37 | 42 | ... | ... | ... | ... | ... | |
| | | M | 18 | 44 | 24 | ... | ... | 50 | ... | ... | |
| | | F | 18 | 49 | 30 | ... | ... | ... | ... | ... | |
| 41 | 27 ... | eP | 9 | 49 | 48 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 9 | 56 | 42 | ... | ... | ... | ... | ... | |
| 42 | May 1 ... | eP | 6 | 52 | 54 | ... | ... | ... | ... | ... | |
| | | eL | 7 | 07 | 06 | ... | ... | ... | ... | ... | |
| | | M | 7 | 10 | 54 | ... | ... | 40 | ... | ... | |
| | | F | 7 | 50 | 06 | ... | ... | ... | ... | ... | |
| 43 | 12 ... | eP | 4 | 34 | 18 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 4 | 57 | 36 | ... | ... | ... | ... | ... | |
| 44 | 13 ... | eP | 20 | 26 | 24 | ... | ... | ... | ... | ... | |
| | | eL | 20 | 31 | 00 | ... | ... | ... | ... | ... | |
| | | M | 20 | 32 | 06 | ... | ... | 30 | ... | ... | |
| | | F | 20 | 42 | 54 | ... | ... | ... | ... | ... | |
| 45 | 13 ... | eP | 21 | 32 | 48 | ... | ... | ... | ... | ... | |
| | | eL | 21 | 35 | 54 | ... | ... | ... | ... | ... | |
| | | M | 21 | 41 | 36 | ... | ... | 40 | ... | ... | |
| | | F | 21 | 48 | 00 | ... | ... | ... | ... | ... | |
| 46 | 14 ... | eP | 11 | 15 | 42 | ... | ... | ... | ... | ... | |
| | | iL | 11 | 43 | 42 | ... | ... | ... | ... | ... | |
| | | M | 11 | 46 | 00 | ... | ... | 140 | ... | ... | |
| | | F | 12 | 11 | 06 | ... | ... | ... | ... | ... | |
| 47 | 14 ... | eP | 13 | 28 | 00 | ... | ... | ... | ... | ... | |
| | | eL | | ? | | ... | ... | ... | ... | ... | |
| | | M | 13 | 32 | 36 | ... | ... | 40 | ... | ... | |
| | | F | 13 | 41 | 36 | ... | ... | ... | ... | ... | |
| 48 | 14 ... | eP | 21 | 20 | 00 | ... | ... | ... | ... | ... | |
| | | eL | 21 | 29 | 00 | ... | ... | ... | ... | ... | |
| | | M | 21 | 31 | 48 | ... | ... | 80 | ... | ... | |
| | | F | 21 | 48 | 12 | ... | ... | ... | ... | ... | |
| 49 | 16 ... | eP | 16 | 11 | 54 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 16 | 24 | 42 | ... | ... | ... | ... | ... | |
| 50 | 20 ... | eP | 0 | 53 | 06 | ... | ... | ... | ... | ... | |
| | | eL | 0 | 54 | 12 | ... | ... | ... | ... | ... | |
| | | M | 0 | 55 | 12 | ... | ... | 130 | ... | ... | |
| | | F | 1 | 18 | 06 | ... | ... | ... | ... | ... | |
| 51 | 21 ... | iP | 8 | 56 | 06 | ... | ... | ... | ... | ... | Times approximate as there is no hour mark on the sheet. |
| | | iL | 9 | 11 | 24 | ... | ... | ... | ... | ... | |
| | | M | 9 | 13 | 54 | ... | ... | 160 | ... | ... | |
| | | F | 9 | 48 | 54 | ... | ... | ... | ... | ... | |
| 52 | 21 ... | eP | 22 | 41 | 00 | ... | ... | ... | ... | ... | |
| | | eL | 23 | 05 | 00 | | ... | ... | ... | ... | |
| | | M | 23 | 10 | 24 | ... | ... | 90 | ... | ... | |
| | | F | 24 | 06 | 48 | ... | ... | ... | ... | ... | |
| 53 | June 2 ... | eP | 7 | 17 | 36 | ... | ... | ... | ... | ... | |
| | | eL | 7 | 20 | 12 | ... | ... | ... | ... | ... | |
| | | M | 7 | 21 | 30 | ... | ... | 60 | ... | ... | |
| | | F | 7 | 43 | 30 | ... | ... | ... | ... | ... | |
| 54 | 18 ... | eP | 15 | 31 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 15 | 34 | 06 | ... | ... | ... | ... | ... | |
| 55 | 20 ... | eP | 2 | 09 | 48 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 2 | 16 | 36 | ... | ... | ... | ... | ... | |
| 56 | 21 ... | eP | 10 | 34 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 10 | 40 | 54 | ... | ... | ... | ... | ... | |
| 57 | 21 ... | eP | 12 | 56 | 54 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 12 | 59 | 00 | ... | ... | ... | ... | ... | |
| 58 | 21 ... | eP | 13 | 09 | 18 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 13 | 14 | 30 | ... | ... | ... | ... | ... | |
| 59 | 25 ... | eP | 12 | 05 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 12 | 08 | 06 | ... | ... | ... | ... | ... | |
| 60 | 28 ... | eP | 14 | 24 | 54 | ... | ... | ... | ... | ... | |
| | | eL | 15 | 00 | 48 | ... | ... | ... | ... | ... | |
| | | M | 15 | 06 | 54 | ... | ... | 40 | ... | ... | |
| | | F | 15 | 13 | 06 | ... | ... | ... | ... | ... | |
| 61 | July 7 ... | eP | 11 | 43 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 12 | 05 | 54 | ... | ... | ... | ... | ... | |
| 62 | 8 ... | eP | 13 | 36 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 13 | 45 | 30 | ... | ... | ... | ... | ... | |
| 63 | 13 ... | eP | 2 | 11 | 24 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 2 | 13 | 54 | ... | ... | ... | ... | ... | |

| No | Date. | Phase. | Time G.M.T. | | | Period (Sec.). | Amplitude (μ). | | | Distance △ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | An. | Ae. | Az. | | |
| | 1921. | | H. | M. | S. | | | | | | |
| 64 | July 25 ... | eP | 19 | 55 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 20 | 02 | 12 | ... | ... | ... | ... | ... | |
| 65 | August 5 ... | eP | 2 | 19 | 36 | ... | ... | ... | ... | ... | Widening of line. Hour mark overlaps. |
| | | F | 2 | 30 | 00? | ... | ... | ... | ... | ... | |
| 66 | 13 ... | eP | 13 | 23 | 36 | ... | ... | ... | ... | ... | |
| | | eL | 13 | 27 | 06 | ... | ... | ... | ... | ... | |
| | | M | 13 | 28 | 42 | ... | ... | 40 | ... | ... | |
| | | F | 13 | 41 | 18 | ... | ... | ... | ... | ... | |
| 67 | 14 ... | iP | 13 | 28 | 30 | ... | ... | ... | ... | ... | |
| | | iL | 13 | 35 | 06 | ... | ... | ... | ... | ... | |
| | | M | 13 | 36 | 54 | ... | ... | 120 | ... | ... | |
| | | F | 14 | 01 | 36 | ... | ... | ... | ... | ... | |
| 68 | 15 ... | eP | 14 | 13 | 42 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 14 | 23 | 18 | ... | ... | ... | ... | ... | |
| 69 | 23 ... | eP | 13 | 56 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 13 | 59 | 12 | ... | ... | ... | ... | ... | |
| 70 | 23 ... | eP | 21 | 01 | 18 | ... | ... | ... | ... | ... | |
| | | eL | 21 | 10 | 18 | ... | ... | ... | ... | ... | |
| | | M | 21 | 12 | 36 | ... | ... | 50 | ... | ... | |
| | | F | 21 | 21 | 18 | ... | ... | ... | ... | ... | |
| 71 | September 1 ... | eP | 10 | 19 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 10 | 25 | 24 | ... | ... | ... | ... | ... | |
| 72 | 2 ... | eP | 5 | 21 | 18 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 5 | 27 | 24 | ... | ... | ... | ... | ... | |
| 73 | 3 ... | eP | 1 | 33 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 1 | 36 | 12 | ... | ... | ... | ... | ... | |
| 74 | 5 ... | eP | 20 | 18 | 12 | ... | ... | ... | ... | ... | |
| | | eL | 20 | 36 | 12 | ... | ... | ... | ... | ... | |
| | | M | 20 | 45 | 06 | ... | ... | 110 | ... | ... | |
| | | F | 21 | 22 | 18 | ... | ... | ... | ... | ... | |
| 75 | 11 ... | P | | ... | | ... | ... | ... | ... | ... | No P.Ts. |
| | | iL | 4 | 09 | 00 | ... | ... | ... | ... | ... | |
| | | M | 4 | 27 | 42 | ... | ... | 1350 | ... | ... | |
| | | F | 7 | 29 | 48 | ... | ... | ... | ... | ... | |
| 76 | 13 ... | eP | 3 | 02 | 06 | ... | ... | ... | ... | ... | |
| | | iL | 3 | 32 | 36 | ... | ... | ... | ... | ... | |
| | | M | 3 | 39 | 18 | ... | ... | 410 | ... | ... | |
| | | F | 4 | 20 | 42 | ... | ... | ... | ... | ... | |
| 77 | 21 ... | iP | 11 | 15 | 18 | ... | ... | ... | ... | ... | |
| | | iL | 11 | 22 | 30 | ... | ... | ... | ... | ... | |
| | | M | 11 | 23 | 48 | ... | ... | 140 | ... | ... | |
| | | F | 11 | 47 | 30 | ... | ... | ... | ... | ... | |
| 78 | 22 ... | eP | 6 | 43 | 48 | ... | ... | ... | ... | ... | |
| | | eL | 6 | 49 | 30 | ... | ... | ... | ... | ... | |
| | | M | 6 | 51 | 00 | ... | ... | 90 | ... | ... | |
| | | F | 7 | 04 | 54 | ... | ... | ... | ... | ... | |
| 79 | October 9 ... | eP | 0 | 25 | 18 | ... | ... | ... | ... | ... | |
| | | eL | 0 | 27 | 30 | ... | ... | ... | ... | ... | |
| | | M | 0 | 32 | 24 | ... | ... | 170 | ... | ... | |
| | | F | 1 | 29 | 00 | ... | ... | ... | ... | ... | |
| 80 | 9 .. | eP | 5 | 07 | 18 | ... | ... | ... | ... | ... | |
| | | eL | 5 | 11 | 54 | ... | ... | ... | ... | ... | |
| | | M | 5 | 13 | 12 | ... | ... | 50 | ... | ... | |
| | | F | 5 | 19 | 42 | ... | ... | ... | ... | ... | |
| 81 | 10 ... | eP | 2 | 18 | 54 | ... | ... | ... | ... | ... | |
| | | eL | 2 | 28 | 24 | ... | ... | ... | ... | ... | |
| | | M | 2 | 32 | 48 | ... | ... | 80 | ... | ... | |
| | | F | | ? | | ... | ... | ... | ... | ... | } Overlapping. |
| 82 | 10 ... | P | | ? | | ... | ... | ... | ... | ... | |
| | | eL | 2 | 39 | 00 | ... | ... | ... | ... | ... | |
| | | M | 2 | 42 | 42 | ... | ... | 80 | ... | ... | |
| | | F | 3 | 06 | 30 | ... | ... | ... | ... | ... | |
| 83 | 12 ... | eP | 8 | 59 | 18 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 9 | 07 | 30 | ... | ... | ... | ... | ... | |
| 84 | 15 ... | eP | 5 | 10 | 24 | ... | ... | ... | ... | ... | |
| | | iL | 5 | 55 | 12 | ... | ... | ... | ... | ... | |
| | | M | 5 | 59 | 48 | ... | ... | 410 | ... | ... | |
| | | F | 7 | 33 | 06 | ... | ... | ... | ... | ... | |
| 85 | 15 ... | eP | 10 | 16 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 10 | 18 | 36 | ... | ... | ... | ... | ... | |
| 86 | 18 ... | eP | 1 | 25 | 00 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 1 | 30 | 18 | ... | ... | ... | ... | ... | |
| 87 | 18 ... | eP | 12 | 54 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | F | 13 | 01 | 24 | ... | ... | ... | ... | ... | |
| 88 | 20 ... | eP | 6 | 25 | 54 | ... | ... | ... | ... | ... | |
| | | eL | 6 | 39 | 42 | ... | ... | ... | ... | ... | |
| | | M | 6 | 40 | 48 | ... | ... | 50 | ... | ... | |
| | | F | 7 | 44 | 24 | ... | ... | ... | ... | ... | |

| No. | Date. | | Phase. | Time G.M.T. | | | Period (Sec.). | Amplitude (μ). An. | Ae. | Az. | Distance △ (Km.). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1921. | | | H. | M | S | | | | | | |
| 89 | October | 26 ... | eP | 7 | 12 | 30 | ... | ... | | ... | ... | Widening of line. |
| | | | F | 7 | 21 | 12 | | ... | ... | ... | ... | |
| 90 | | 26 ... | eP | 23 | 09 | 42 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 23 | 19 | 00 | ... | ... | ... | ... | ... | |
| 91 | November | 2 ... | eP | 9 | 12 | 12 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 9 | 28 | 24 | ... | ... | ... | ... | ... | |
| 92 | | 2 ... | eP | 9 | 45 | 30 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 10 | 08 | 48 | ... | ... | ... | ... | | |
| 93 | | 7 ... | eP | 16 | 08 | 36 | ... | ... | ... | ... | ... | |
| | | | eL | 16 | 15 | 18 | ... | ... | | ... | ... | |
| | | | M | 16 | 32 | 06 | ... | ... | 160 | ... | | |
| | | | F | 17 | 07 | 36 | ... | ... | ... | ... | ... | |
| 94 | | 11 ... | P | | .. | | ... | ... | ... | ... | ... | No P Ts. |
| | | | iL | 18 | 45 | 30 | ... | ... | | ... | ... | |
| | | | M | 19 | 09 | 06 | ... | ... | 1200 | ... | ... | |
| | | | F | 21 | 49 | 36 | ... | ... | ... | ... | ... | |
| 95 | | 14 ... | eP | 7 | 50 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 8 | 01 | 54 | ... | ... | ... | ... | | |
| 96 | | 15 ... | eP | 20 | 42 | 24 | ... | ... | | ... | ... | |
| | | | iL | 20 | 45 | 24 | ... | ... | ... | ... | ... | |
| | | | M | 20 | 51 | 36 | ... | ... | 900 | ... | ... | |
| | | | F | 21 | 59 | 42 | ... | ... | ... | ... | ... | |
| 97 | | 16 ... | eP | 15 | 41 | 36 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 15 | 46 | 12 | ... | ... | ... | | ... | |
| 98 | | 17 ... | eP | 8 | 18 | 06 | ... | ... | ... | ... | ... | Widening of line. |
| | | | F | 8 | 27 | 24 | ... | ... | ... | ... | | |
| 99 | | 18 ... | eP | 3 | 03 | 54 | ... | ... | ... | ... | | Widening of line. |
| | | | F | 3 | 10 | 00 | ... | ... | ... | ... | ... | |
| 100 | December | 7 ... | eP | 17 | 37 | 12 | ... | ... | ... | ... | ... | |
| | | | eL | 17 | 57 | 24 | ... | ... | ... | | ... | |
| | | | M | 18 | 00 | 18 | ... | ... | 60 | ... | ... | |
| | | | F | 18 | 12 | 48 | ... | ... | | ... | ... | |
| 101 | | 8 ... | eP | 13 | 11 | 18 | ... | ... | ... | ... | ... | |
| | | | eL | 13 | 12 | 36 | ... | ... | ... | ... | ... | |
| | | | M | 13 | 15 | 24 | ... | ... | 40 | ... | ... | |
| | | | F | 13 | 23 | 06 | ... | | ... | ... | ... | |
| 102 | | 12 ... | eP | 2 | 22 | 36 | ... | ... | ... | ... | ... | Widening of line. F merged in the hour mark at $2^h$ $30^m$. |
| | | | F | | ? | | ... | ... | ... | ... | ... | |
| 103 | | 18 ... | eP | 15 | 48 | 12 | ... | ... | ... | ... | ... | |
| | | | iL | 16 | 01 | 48 | ... | | | ... | ... | |
| | | | M | 16 | 02 | 18 | ... | ... | 50 | | ... | |
| | | | F | | ? | | | ... | ... | ... | ... | } Overlapping. |
| 104 | | 18 ... | P | | ? | | ... | ... | | ... | ... | |
| | | | eL | 17 | 00 | 00 | ... | ... | | ... | ... | |
| | | | M | 17 | 08 | 42 | ... | ... | 50 | ... | ... | |
| | | | F | 17 | 36 | 42? | ... | ... | ... | ... | ... | |
| 105 | | 18 ... | eP | 23 | 41 | 00 | ... | | ... | ... | ... | Widening of line. |
| | | | F | 23 | 45 | 24 | ... | ... | ... | ... | ... | |

# APPENDIX II.

Latitude 10° 13′ 50″ N.

Longitude $5^h\ 9^m\ 52^s$ E.

Height of Barometer cistern above mean sea level 7688 feet.

MEAN Monthly and Annual Meteorological Results at the Kodaikanal Observatory in 1921.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily Range. | Dry Bulb Thermometer. Mean. | Dry Bulb Thermometer. Max. | Dry Bulb Thermometer. Min. | Dry Bulb Thermometer. Range. | Wet Bulb. Mean. | Wet Bulb. Min. | Tension of Vapour. By Simpson's Tables. | Relative Humidity. By Simpson's Tables. | Sun Max. in Vac. | Min. on Grass. | Wind. Daily Velocity | Wind. Mean Direction. | Wind. Mean Direction. | Rain Amount. | Rain Days. | Clear sky. | Bright sun-shine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Inches. | ° | ° | ° | ° | ° | ° | Inches. | Cents. | ° | ° | Miles. | Points | Points. | Inches. | No. | Cents. | Hours. |
| January | 22·839 | 0·064 | 55·4 | 62·4 | 48·3 | 14·1 | 49·7 | 44·1 | 0·307 | 71 | 114·2 | 42·1 | 316 | 7 | E by N. | 13·58 | 11 | 41 | 196·6 |
| February | ·831 | ·064 | 55·7 | 66·1 | 45·3 | 20·8 | 45·9 | 40·1 | ·213 | 50 | 126·4 | 36·8 | 285 | 19 | S.W. by S. | ... | ... | 77 | 285·4 |
| March | ·838 | ·060 | 60·7 | 71·5 | 49·9 | 21·6 | 47·7 | 40·0 | ·204 | 39 | 133·8 | 38·9 | 303 | 6 | E.N.E. | ... | ... | 85 | 323·1 |
| April | ·838 | ·066 | 59·1 | 69·1 | 52·4 | 16·7 | 54·0 | 48·7 | ·360 | 72 | 131·4 | 45·4 | 236 | 12 | S.E. | 9·86 | 11 | 41 | 207·4 |
| May | ·792 | ·062 | 62·0 | 72·8 | 55·2 | 17·6 | 55·4 | 49·8 | ·370 | 66 | 133·4 | 46·8 | 194 | 1 | N. by E. | 4·36 | 8 | 45 | 211·3 |
| June | ·745 | ·057 | 58·3 | 66·4 | 53·4 | 13·0 | 54·8 | 50·7 | ·393 | 81 | 126·0 | 48·1 | 252 | 23 | W. by S. | 4·11 | 10 | 27 | 126·2 |
| July | ·743 | ·052 | 55·3 | 63·2 | 52·7 | 10·5 | 54·2 | 50·8 | ·397 | 88 | 114·0 | 48·6 | 313 | 25 | W. by N. | 7·53 | 17 | 12 | 77·9 |
| August | ·773 | ·062 | 56·9 | 64·8 | 52·3 | 12·5 | 54·3 | 50·6 | ·349 | 89 | 122·1 | 48·1 | 238 | 23 | W. by S | 11·72 | 16 | 26 | 136·2 |
| September | ·794 | ·062 | 56·0 | 63·7 | 51·1 | 12·6 | 52·5 | 47·8 | ·350 | 80 | 121·7 | 46·9 | 276 | 23 | W by S. | 4·25 | 11 | 27 | 160·6 |
| October | ·809 | ·068 | 55·7 | 63·3 | 51·0 | 12·3 | 53·6 | 49·4 | ·390 | 88 | 118·1 | 47·1 | 207 | 30 | N.N.W. | 12·59 | 19 | 18 | 123·9 |
| November | ·854 | ·055 | 54·7 | 63·0 | 48·0 | 15·0 | 51·3 | 45·4 | ·344 | 80 | 116·2 | 42·2 | 199 | 18 | S.S.W. | 3·70 | 6 | 43 | 172·7 |
| December | ·833 | ·057 | 54·8 | 65·7 | 47·1 | 18·6 | 46·3 | 39·6 | ·231 | 55 | 116·3 | 38·4 | 301 | 9 | E. by S. | 5·82 | 5 | 49 | 214·6 |
| Annual | 22·807 | 0·061 | 57·1 | 66·0 | 50·6 | 15·4 | 51·6 | 46·4 | 0·326 | 72 | 122·8 | 44·1 | 260 | 22 | W.S.W | 77·52 | 114 | 41 | 2235·9 |

EXTREME Monthly Meteorological Records at the Kodaikanal Observatory in 1921.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry Bulb Thermometer. Highest. | | Dry Bulb Thermometer. Lowest. | | Wet Bulb. Lowest. | | Humidity. Lowest. | | Sun Th in Vacuo. Highest. | | Grass Therm Lowest. | | Wind. Highest | | Wind. Lowest. | | Rain. Greatest Fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Day. | Inches. | Day. | Inches. | ° | Day. | ° | Day. | ° | Day. | Cents. | Day. | ° | Day. | ° | Day. | Miles. | Day. | Miles. | Day. | Inches. | Day. |
| January | 22·836 | 3, 5 | 22·760 | 12 | 0·136 | 69·7 | 1 | 42·0 | 27 | 34·6 | 29, 30 | 15 | 6, 30 | 132·9 | 1 | 30·3 | 29 | 546 | 9 | 144 | 24 | **6·91** | **14** |
| February | ·902 | 25 | ·764 | 6 | ·138 | 72·4 | 27 | **40·3** | **26** | 33·1 | 27 | **3** | **28** | 134·9 | 15 | 29·4 | 6 | 470 | 17 | 165 | 8 | ... | ... |
| March | **·920** | **16** | ·735 | 3 | ·185 | 74·6 | 24 | 45·6 | 5 | 33·2 | 5 | 7 | 14 | 136·9 | 10 | 32·5 | 14 | 463 | 5 | 175 | 31 | ... | ... |
| April | ·902 | 19 | ·753 | 6 | ·149 | 73·5 | 5 | 49·4 | 3 | 43·3 | 26 | 34 | 26 | **141·9** | **12** | 39·6 | 3 | 370 | 30 | 114 | 17 | 2·58 | 14 |
| May | ·881 | 1 | ·701 | 13 | ·180 | **76·5** | **9** | 50·3 | 1 | 40·7 | 1 | 29 | 6 | **141·9** | **17** | 41·7 | 1 | 300 | 12 | 125 | 15, 23 | 1·32 | 25 |
| June | ·821 | 4 | ·668 | 19 | ·153 | 72·2 | 2 | 51·2 | 30 | 47·1 | 16 | 52 | 1 | 135·9 | 11 | 42·5 | 30 | 515 | 21 | 108 | 28 | 0·94 | 7 |
| July | ·834 | 19 | **·657** | **6** | ·177 | 66·7 | 1 | 51·2 | 8 | 46·3 | 8 | 61 | 2 | 126·3 | 20 | 43·2 | 2 | 516 | 30 | 100 | 2 | 0·90 | 11 |
| August | ·835 | 1 | ·702 | 20 | ·133 | 68·2 | 28 | 50·7 | 21 | 48·2 | 18 | 58 | 9 | 138·9 | 24 | 44·0 | 15 | 432 | 1 | 120 | 25 | 1·37 | 1 |
| September | ·873 | 26 | ·696 | 2 | ·177 | 66·3 | 22 | 49·4 | 4, 30 | 40·6 | 15 | 34 | 15 | 136·1 | 22 | 43·5 | 15 | 565 | 3 | 111 | 9 | 0·64 | 10 |
| October | ·889 | 19 | ·705 | 8 | ·184 | 65·7 | 13 | 44·2 | 23 | 37·6 | 23 | 44 | 23 | 132·8 | 6 | 37·2 | 23 | 334 | 27 | 133 | 8 | 1·29 | 29 |
| November | ·918 | 29 | ·773 | 6 | ·145 | 68·3 | 30 | 41·4 | 21 | **32·7** | **21** | 15 | 15 | 129·6 | 13 | 30·4 | 15 | 376 | 20 | 118 | 12 | 1·76 | 1 |
| December | ·918 | 5 | ·755 | 29 | ·163 | 72·8 | 2 | 40·8 | 25 | 34·2 | 22 | 9 | 25 | 131·4 | 12 | **27·2** | **8** | **610** | **30** | **89** | **26** | 2·62 | 30 |

# APPENDIX III.

KODAIKANAL mean hourly wind velocity for the year 1921.

| Month. | Hours. | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| January | 13 | 13 | 14 | 14 | 13 | 14 | 15 | 14 | 15 | 16 | 15 | 14 | 14 | 12 | 12 | 11 | 11 | 11 | 12 | 12 | 13 | 12 | 12 | 14 |
| February | 14 | 14 | 14 | 14 | 14 | 13 | 13 | 12 | 13 | 14 | 13 | 13 | 12 | 11 | 9 | 8 | 7 | 7 | 8 | 10 | 11 | 12 | 14 | 15 |
| March | 13 | 14 | 13 | 13 | 13 | 13 | 13 | 15 | 16 | 17 | 17 | 16 | 15 | 13 | 12 | 10 | 9 | 7 | 7 | 9 | 10 | 12 | 13 | 13 |
| April | 10 | 10 | 10 | 10 | 12 | 11 | 11 | 11 | 12 | 11 | 11 | 11 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 8 | 9 | 9 | 10 | 10 |
| May | 10 | 10 | 9 | 10 | 9 | 9 | 8 | 7 | 7 | 8 | 8 | 8 | 7 | 7 | 8 | 8 | 7 | 7 | 7 | 7 | 7 | 8 | 9 | 9 |
| June | 11 | 12 | 11 | 11 | 11 | 11 | 11 | 10 | 10 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 9 | 11 | 11 | 11 | 11 | 11 | 12 |
| July | 14 | 15 | 14 | 15 | 16 | 15 | 13 | 15 | 13 | 12 | 12 | 12 | 12 | 10 | 10 | 10 | 12 | 12 | 13 | 14 | 13 | 14 | 13 | 14 |
| August | 12 | 12 | 11 | 11 | 12 | 11 | 11 | 9 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 10 | 11 | 11 | 10 | 10 | 12 | 13 |
| September | 12 | 12 | 13 | 14 | 14 | 14 | 13 | 13 | 12 | 11 | 11 | 11 | 11 | 9 | 9 | 9 | 9 | 10 | 11 | 11 | 12 | 11 | 12 | 12 |
| October | 9 | 9 | 9 | 10 | 9 | 10 | 9 | 9 | 9 | 9 | 9 | 8 | 8 | 8 | 8 | 8 | 7 | 8 | 7 | 8 | 9 | 9 | 9 | 9 |
| November | 8 | 8 | 10 | 9 | 10 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 9 | 8 | 8 | 7 | 6 | 6 | 6 | 4 | 8 | 8 | 8 | 9 |
| December | 14 | 13 | 13 | 13 | 12 | 12 | 13 | 12 | 13 | 16 | 15 | 14 | 13 | 13 | 12 | 10 | 9 | 10 | 11 | 12 | 13 | 13 | 13 | 12 |
| Mean | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 11 | 11 | 12 | 12 | 11 | 11 | 10 | 10 | 9 | 9 | 9 | 9 | 10 | 11 | 11 | 11 | 12 |

## APPENDIX IV.

KODAIKANAL mean hourly bright sunshine for the year 1921.

| Month. | Hours. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6–7 | 7–8 | 8–9 | 9–10 | 10–11 | 11–12 | 12–13 | 13–14 | 14–15 | 15–16 | 16–17 | 17–18 |
| January | 0·15 | 0·52 | 0·61 | 0·69 | 0·76 | 0·68 | 0 68 | 0·66 | 0 59 | 0·54 | 0·38 | 0 07 |
| February | ·43 | ·99 | 95 | ·97 | ·97 | ·97 | ·98 | ·95 | ·91 | ·86 | ·79 | ·41 |
| March | ·61 | 1·00 | 99 | 1·00 | 1·00 | ·96 | ·93 | ·90 | ·89 | ·83 | ·79 | ·53 |
| April | ·32 | 0·70 | ·81 | 0·86 | 0·82 | ·82 | ·73 | ·63 | ·51 | ·38 | ·24 | ·12 |
| May | ·23 | ·69 | ·87 | ·90 | ·95 | ·88 | ·68 | ·59 | ·46 | ·29 | ·18 | ·09 |
| June | ·12 | ·41 | ·54 | ·60 | ·56 | ·43 | ·35 | ·38 | ·36 | ·30 | ·13 | ·03 |
| July | ·06 | ·23 | ·40 | ·43 | ·41 | ·41 | ·29 | ·14 | ·08 | ·04 | ·03 | ... |
| August | ·16 | ·51 | ·68 | ·69 | ·60 | ·53 | ·48 | ·28 | ·21 | ·12 | ·12 | ·01 |
| September | ·15 | ·55 | ·66 | ·72 | ·70 | ·68 | ·56 | ·47 | ·36 | ·25 | ·19 | ·07 |
| October | ·12 | ·33 | ·42 | ·57 | ·60 | ·48 | ·42 | ·36 | ·37 | ·22 | ·09 | ·02 |
| November | ·14 | ·57 | ·66 | ·72 | ·71 | ·64 | ·60 | ·58 | ·42 | ·41 | ·30 | ·01 |
| December | ·09 | ·65 | ·74 | ·77 | ·77 | ·75 | ·72 | ·74 | ·67 | ·57 | ·46 | ... |
| Mean | 0·22 | 0·60 | 0·69 | 0·74 | 0·74 | 0·69 | 0 62 | 0·56 | 0·49 | 0·40 | 0·31 | 0·11 |

## APPENDIX V.

NUMBER of days in each month on which the Nilgiris were visible in 1921.

| Month. | Very clear. | Visible. | Just visible. | Tops only visible. | Total. |
|---|---|---|---|---|---|
| January | 1 | 11 | 1 | ... | 13 |
| February | .. | 3 | 1 | ... | 4 |
| March | 1 | 1 | 1 | .. | 3 |
| April | .. | 1 | 2 | 1 | 4 |
| May | ... | 1 | ... | ... | 1 |
| June | 3 | 5 | 2 | ... | 10 |
| July | 2 | 3 | ... | ... | 5 |
| August | 1 | 1 | 2 | ... | 4 |
| September | 3 | 2 | 3 | ... | 8 |
| October | 6 | 4 | 1 | 1 | 12 |
| November | 2 | 6 | 1 | 1 | 10 |
| December | 1 | 17 | ... | 3 | 21 |
| Total | 20 | 55 | 14 | 6 | 95 |

# APPENDIX VI.

MADRAS OBSERVATORY.—Abnormals from monthly means for the year 1921.

| Abnormals of | January. | February. | March. | April. | May. | June. | July. | August. | September | October. | November. | December. | Annual. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduced atmospheric pressure ... ... ... | − 0·033 | − 0·030 | − 0·043 | + 0·003 | − 0·075 | − 0·044 | − 0·021 | − 0·008 | + 0·005 | + 0·021 | + 0·060 | + 0·015 | − 0·012 |
| Temperature of air ... ... ... ... ... | + 2·3 | Normal | + 0·8 | Normal | + 3·1 | + 2·1 | − 0·6 | + 0·4 | + 0·3 | − 0·9 | − 0·3 | + 0·4 | + 0·6 |
| Do. of evaporation ... ... ... | + 3·3 | − 1·1 | + 0·6 | + 0·3 | + 0·2 | + 0·2 | + 1·5 | + 1·5 | + 0·2 | + 0·7 | − 1·3 | − 0·1 | − 2·5 |
| Percentage of humidity .. ... ... ... | + 5 | − 5 | − 1 | + 1 | − 8 | − 5 | + 10 | + 5 | Normal | + 7 | − 4 | − 2 | Normal |
| Greatest solar heat in *vacuo* ... .. ... | + 6·5 | +10·6 | +10·7 | +10·7 | +12·2 | +10·1 | + 2·1 | + 7·7 | + 8·8 | + 0·3 | +12·2 | + 8·6 | + 8·4 |
| Maximum in shade ... ... ... ... | − 0·2 | − 0·3 | + 0·9 | − 0·5 | + 6·8 | + 2·2 | − 2·4 | − 0·1 | − 0·1 | − 3·1 | + 0·1 | + 0·6 | + 0·3 |
| Minimum in shade .. ... ... ... ... | + 4·1 | − 0·6 | + 0·2 | + 0·8 | + 2·0 | + 1·9 | − 0·6 | + 0·2 | − 0·1 | − 0·3 | − 2·2 | − 0·4 | + 0·4 |
| Do. on grass ... ... ... ... | + 6·0 | − 0·1 | + 0·3 | + 1·3 | + 2·3 | + 2·2 | − 0·3 | + 0·3 | Normal | + 0·8 | − 2·9 | − 0·2 | + 0·9 |
| Rainfall in inches ... ... .. ... ... | + 4·57 | − 0·28 | − 0·39 | + 1·37 | − 2·12 | − 1·46 | + 4·47 | + 2·73 | − 2·14 | +13·27 | −11·37 | − 3·24 | − |
| Do. since January 1st ... ... ... | + 4·57 | + 4·29 | + 3·90 | + 5·27 | + 3·15 | + 1·69 | + 6·16 | + 8·89 | + 6·75 | +20·02 | + 8·65 | + 5·41 | + 5·41 |
| General direction of wind ... .. ... ... | Normal | 2 points S. | 2 points S. | 2 points S. | 2 points W. | Normal | 1 point S. | 2 points S. | Normal | 8 points S. | 3 points W. | Normal | 3 points S. |
| Daily velocity of wind in miles ... ... ... | − 38 | − 75 | − 69 | − 65 | − 55 | − 49 | − 49 | − 36 | − 26 | − 12 | − 29 | − 18 | −44 |
| Percentage of cloudy sky ... ... ... ... | + 16 | − 6 | − 12 | + 11 | − 13 | − 5 | + 4 | − 7 | − 5 | + 15 | − 22 | + 2 | − 2 |
| Do. of bright sunshine ... ... ... | − 14·3 | + 3·2 | + 0·5 | − 3·3 | − 6·5 | − 2·7 | − 11 | + 4 | + 1·0 | − 21·1 | + 14 | − 10·7 | − 8·8 |

+ means *above* normal ; − means *below* normal.

## APPENDIX VII.

ABSTRACT of the Mean Meteorological Condition of Madras in the year 1921 compared with the average of past years.

| Mean values of | 1921. | Difference from | Average. |
|---|---|---|---|
| Reduced atmospheric pressure ... ... ... ... ... | 29·852 | 0·012 below. | 29·864 |
| Temperature of air ... ... ... ... ... ... | 81·7 | 0·6 above. | 81·1 |
| Do. of evaporation ... ... ... ... ... | 72·0 | 2·5 below. | 74·5 |
| Percentage of humidity ... ... ... ... ... ... | 72 | Normal | 72 |
| Greatest solar heat in *vacuo* ... ... ... ... ... | 148·1 | 8·4 above. | 139·7 |
| Maximum in shade .. ... ... ... ... ... | 91·1 | 0·3 ,, | 90·8 |
| Minimum in shade ... ... ... ... ... ... | 75·1 | 0·4 ,, | 74·7 |
| Do. on grass ... ... ... ... ... ... | 72·8 | 0·9 ,, | 71·9 |
| Rainfall in inches on 96 days ... ... ... ... ... | 54·43 | 5·41 ,, | 49·02 |
| General direction of wind ... ... ... ... ... | S. by E. | 3 points S. | S.E. |
| Daily velocity in miles ... ... ... ... ... ... | 127 | 44 below. | 171 |
| Percentage of cloudy sky ... ... ... ... ... | 47 | 2 ,, | 49 |
| Do. of bright sunshine ... ... ... ... ... | 49·6 | 8·8 ,, | 58·4 |

DURATION and quantity of the wind from different points.

| From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. | From | Hours. | Miles. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| North. | 193 | 914 | East. | 79 | 413 | South. | 176 | 1181 | West. | 111 | 758 |
| N. by E. | 343 | 2457 | E. by S. | 240 | 1257 | S. by W. | 295 | 1755 | W. by N. | 112 | 746 |
| N.N.E. | 604 | 3823 | E.S.E. | 282 | 1390 | S.S.W. | 361 | 2284 | W.N.W. | 124 | 704 |
| N.E. by N. | 191 | 1398 | S.E. by E. | 243 | 1224 | S.W. by S. | 290 | 1871 | N.W. by W. | 67 | 411 |
| N.E. | 73 | 557 | S.E. | 166 | 970 | S.W. | 190 | 1182 | N.W. | 54 | 298 |
| N.E. by E. | 148 | 918 | S.E. by S. | 378 | 2026 | S.W. by W. | 312 | 2073 | N.W. by N. | 73 | 443 |
| E.N.E. | 99 | 563 | S.S.E. | 532 | 2917 | W.S.W. | 420 | 2834 | N.N.W. | 159 | 963 |
| E. by N. | 104 | 639 | S. by E. | 391 | 2713 | W. by S. | 220 | 1456 | N. by W. | 590 | 3433 |

There were 1120 calm hours during the year. The resultant corresponding to the above numbers is represented by a S.S.E. wind, blowing with a uniform daily velocity of 9·4 miles.

## APPENDIX VIII.

MADRAS OBSERVATORY.—Number of hours of wind from each point during the year 1921.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | ... | 46 | 86 | 74 | 17 | 97 | 36 | 48 | 18 | 46 | 25 | 7 | ... | ... | 3 | 13 | 1 | 10 | 3 | ... | .. | ... | . | . | ... | ... | ... | ... | ... | ... | ... | ... | 214 |
| February | ... | ... | 6 | 4 | 12 | 25 | 10 | 17 | 18 | 57 | 34 | 37 | 14 | 43 | 35 | 4 | 11 | 3 | 7 | 2 | 1 | 2 | 4 | ... | ... | ... | .. | ... | ... | ... | ... | ... | 326 |
| March | ... | ... | .. | ... | .. | .. | ... | ... | ... | ... | 5 | 56 | 20 | 163 | 83 | 41 | 6 | 40 | 33 | 23 | 1 | 7 | ... | ... | . | ... | . | ... | ... | ... | ... | ... | 266 |
| April | 3 | 6 | 8 | 3 | 1 | 1 | 5 | 4 | 5 | 10 | 2 | 52 | 50 | 62 | 137 | 40 | 25 | 35 | 51 | 21 | 9 | 11 | 8 | .. | . | 1 | 2 | 3 | 3 | 8 | 10 | 5 | 139 |
| May | 1 | ... | ... | 1 | 5 | .. | 2 | 2 | 3 | 2 | 8 | 18 | 22 | 57 | 92 | 100 | 62 | 53 | 60 | 45 | 28 | 44 | 49 | 15 | 13 | 13 | 16 | 4 | 3 | 2 | 1 | | 23 |
| June | 6 | ... | 2 | .. | 1 | 2 | 7 | 1 | 11 | 22 | 27 | 15 | 16 | 18 | 53 | 66 | 10 | 18 | 19 | 41 | 19 | 56 | 105 | 60 | 22 | 33 | 17 | 4 | 10 | 25 | 9 | 3 | 22 |
| July | 2 | 1 | ... | .. | 3 | ... | 3 | 10 | 4 | 27 | 29 | 3 | 9 | 10 | 36 | 32 | 23 | 12 | 46 | 94 | 58 | 86 | 91 | 35 | 23 | 13 | 14 | 19 | 11 | 20 | 3 | 8 | 19 |
| August | ... | .. | 1 | 2 | 2 | 2 | 2 | 5 | 3 | 31 | 52 | 11 | 2 | 19 | 49 | 51 | 27 | 55 | 103 | 31 | 29 | 57 | 82 | 41 | 22 | 14 | 17 | 8 | 3 | 1 | 1 | 1 | ... |
| September | 24 | ... | 1 | 10 | 5 | 13 | 3 | 8 | 12 | 38 | 31 | 16 | 2 | 3 | 29 | 31 | 7 | 13 | 37 | 25 | 34 | 44 | 71 | 67 | 30 | 32 | 41 | 20 | 10 | 16 | 17 | 14 | 16 |
| October | 59 | 40 | 80 | 12 | 5 | 3 | 18 | 4 | 2 | 7 | 69 | 28 | 31 | 3 | 15 | 13 | 4 | 56 | 2 | 8 | 11 | 5 | 10 | 2 | 1 | 6 | 17 | 9 | 14 | 1 | 118 | 44 | 47 |
| November | 96 | 36 | 41 | 8 | 1 | . | . | ... | ... | | ... | ... | ... | .. | ... | ... | ... | ... | ... | | ... | ... | .. | .. | ... | ... | ... | ... | ... | ... | ... | 515 | 23 |
| December | 2 | 214 | 379 | 77 | 21 | 5 | 13 | 5 | 3 | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | ... | .. | ... | ... | | | ... | .. | 25 |
| Annual | 193 | 343 | 604 | 191 | 73 | 148 | 99 | 104 | 79 | 240 | 282 | 243 | 166 | 378 | 532 | 391 | 176 | 295 | 361 | 290 | 190 | 312 | 420 | 220 | 111 | 112 | 124 | 67 | 54 | 73 | 159 | 590 | 1120 |

# APPENDIX IX.

MADRAS OBSERVATORY.—Number of miles of wind from each point during the year 1921.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | . | 273 | 577 | 584 | 117 | 659 | 253 | 303 | 77 | 204 | 93 | 35 | | .. | 6 | 30 | 6 | 55 | 21 | ... | .. | ... | ... | .. | . | . | .. | ... | ... | ... | . | ... | 3293 |
| February | ... | ... | 17 | 19 | 105 | 112 | 40 | 64 | 66 | 222 | 119 | 96 | 35 | 159 | 121 | 12 | 48 | 14 | 28 | 4 | 5 | 5 | 11 | ... | .. | .. | ... | .. | | .. | ... | .. | 1302 |
| March | | ... | | .. | ... | .. | ... | ... | ... | ... | 24 | 234 | 100 | 726 | 435 | 281 | 47 | 309 | 226 | 131 | 11 | 39 | ... | ... | ... | ... | ... | .. | .. | ... | ... | .. | 2563 |
| April | 12 | 45 | 105 | 45 | 8 | 2 | 29 | 29 | 35 | 50 | 11 | 288 | 278 | 364 | 697 | 295 | 192 | 312 | 457 | 181 | 72 | 36 | 24 | ... | ... | 7 | 8 | 22 | 16 | 64 | 61 | 25 | 3770 |
| May | 5 | ... | ... | 6 | 25 | .. | 7 | 6 | 5 | 16 | 54 | 155 | 182 | 364 | 668 | 873 | 441 | 384 | 444 | 309 | 190 | 306 | 415 | 111 | 104 | 115 | 125 | 28 | 17 | 9 | 5 | ... | 5369 |
| June | 46 | . | 26 | | 5 | 18 | 43 | 8 | 73 | 163 | 215 | 118 | 133 | 124 | 349 | 470 | 88 | 130 | 129 | 284 | 121 | 507 | 756 | 383 | 159 | 260 | 115 | 23 | 94 | 185 | 89 | 20 | 5134 |
| July | 15 | 8 | .. | .. | 19 | .. | 21 | 71 | 29 | 128 | 160 | 18 | 46 | 89 | 247 | 221 | 122 | 68 | 239 | 543 | 372 | 588 | 629 | 202 | 110 | 76 | 59 | 70 | 46 | 79 | 18 | 19 | 4312 |
| August | ... | ... | 3 | 16 | 12 | 13 | 14 | 35 | 21 | 192 | 287 | 56 | 6 | 113 | 248 | 283 | 162 | 287 | 560 | 194 | 161 | 341 | 532 | 318 | 155 | 71 | 90 | 59 | 19 | 7 | 4 | 8 | 4267 |
| September | 93 | ... | 6 | 63 | 39 | 40 | 19 | 53 | 68 | 264 | 96 | 67 | 8 | 65 | 102 | 151 | 47 | 67 | 155 | 139 | 201 | 228 | 425 | 426 | 221 | 185 | 252 | 141 | 59 | 95 | 81 | 54 | 3910 |
| October | 318 | 252 | 326 | 23 | 17 | 24 | 63 | 28 | 16 | 18 | 331 | 157 | 182 | 22 | 44 | 97 | 28 | 129 | 25 | 86 | 49 | 23 | 42 | 16 | 9 | 32 | 55 | 68 | 47 | 4 | 706 | 203 | 3440 |
| November | 399 | 207 | 283 | 83 | 14 | ... | | ... | | | ... | | | . | . | ... | ... | .. | .. | ... | | ... | .. | ... | .. | ... | ... | ... | . | .. | . | 3104 | 4090 |
| December | 26 | 1672 | 2480 | 559 | 196 | 50 | 74 | 42 | 23 | ... | ... | .. | | ... | ... | ... | .. | ... | ... | ... | .. | . | ... | . | ... | ... | ... | . | ... | ... | ... | ... | 5122 |
| Annual | 914 | 2457 | 3823 | 1398 | 557 | 918 | 563 | 639 | 413 | 1257 | 1390 | 1224 | 970 | 2026 | 2917 | 2713 | 1181 | 1755 | 2284 | 1871 | 1182 | 2073 | 2834 | 1456 | 758 | 746 | 704 | 411 | 298 | 443 | 964 | 3433 | 46572 |

# APPENDIX X.

MADRAS OBSERVATORY.—Number of inches of rain from each point during the year 1921.

| Month. | N. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | E. | 9 | 10 | 11 | 12 | 13 | 14 | 15 | S. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | W. | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Calm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | ... | ... | 0·49 | 0·59 | 0·34 | 0·63 | 1·60 | 1·21 | 0·04 | 0·09 | 0·14 | 0·04 | ... | ... | ... | ... | ... | 0·13 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·16 |
| February | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| March | ... | ... | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| April | ... | ... | 0·29 | 0·05 | ... | 0·15 | 0·09 | ... | 0·10 | 0·03 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·95 | ... | 0·02 | ... | ... | ... | ... | 0·04 | ... | ... | ... | 0·06 | ... | 0·21 |
| May | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| June | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·04 | ... | ... | 0·04 | 0·05 | ... | ... | 0·01 | 0·04 | ... | 0·47 | ... | ... |
| July | 0·40 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·03 | 0·44 | ... | 0·07 | 1·19 | 0·38 | ... | 0·14 | 0·99 | 0·42 | 0·79 | ... | 1·06 | 0·47 | 1·51 | 0·02 | ... | 0·10 | 0·12 | 0·02 | ... | ... | 0·19 |
| August | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·10 | ... | ... | ... | 0·03 | 1·49 | 0·01 | 0·51 | 0·24 | ... | 1·07 | 0·13 | 1·24 | 0·83 | 0·40 | ... | 0·50 | ... | 0·64 | ... | 0·10 | ... | ... |
| September | 0·27 | ... | | ... | ... | ... | 0·02 | 0·03 | ... | 0·06 | 0·04 | ... | ... | 0·33 | 0·24 | 0·12 | 0·02 | 0·07 | 0·01 | 0·01 | 0·05 | 0·15 | 0·26 | 0·29 | 0·39 | 0·02 | 0·04 | 0·13 | ... | ... | ... | ... | ... |
| October | 4·74 | 0·53 | 0·67 | 0·06 | 0·24 | ... | 0·68 | | ... | 0·68 | 0·10 | ... | 0·72 | 0·30 | ... | 0·06 | 0·42 | 0·84 | 0·19 | 0·14 | 0·99 | 0·95 | 0·37 | 0·01 | ... | 1·14 | 0·91 | 0·59 | 0·08 | ... | 7·79 | 1·06 | 0·01 |
| November | 1·12 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0·72 | ... |
| December | ... | 0·05 | 1·49 | | 0·24 | ... | 0·21 | ... | 0·05 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Annual | 6·53 | 0·58 | 2·94 | 0·70 | 0·82 | 0·78 | 2·60 | 1·24 | 0·19 | 0·86 | 0·41 | 0·48 | 0·72 | 0·70 | 1·46 | 2·05 | 0·45 | 1·69 | 1·43 | 1·52 | 2·94 | 1·25 | 2·93 | 1·64 | 2·35 | 1·18 | 1·49 | 0·83 | 0·88 | 0·02 | 8·42 | 1·78 | 0·57 |

# APPENDIX XI.

MADRAS OBSERVATORY.—Wind, cloud and bright sunshine, 1921.

| Month. | Wind resultant. | | Clouds (0—10). | | | | | Bright sunshine. | |
|---|---|---|---|---|---|---|---|---|---|
| | Velocity. | Direction. | 8 H. | 10 H. | 16 H. | 20 H. | Mean. | Average per day. | Greatest number of hours in a day. |
| | MILES. | POINTS. | | | | | | HOURS. | HOURS. |
| January | 91 | N.E. | 5·3 | 7·2 | 4·6 | 4·1 | 5·3 | 6·1 | 9·5 |
| February | 34 | S S.E. | 1·6 | 2·6 | 2·4 | 0·6 | 1·8 | 9·4 | 10·9 |
| March | 74 | E. by S. | 1·1 | 3·0 | 0·5 | 0·2 | 1·2 | 8·9 | 10·6 |
| April | 82 | S.S.E. | 4·5 | 4·1 | 3·6 | 3·2 | 3·9 | 8·2 | 10·7 |
| May | 126 | S. by W. | 3·2 | 2·8 | 2·4 | 1·4 | 2·5 | 6·9 | 9·4 |
| June | 84 | S.W. | 6·1 | 5·4 | 6·8 | 5·0 | 5·9 | 4·8 | 8·4 |
| July | 87 | S.W. by S. | 8·0 | 7·8 | 8·1 | 6·0 | 7·5 | 2·5 | 8·2 |
| August | 82 | S.S.W. | 6·3 | 6·0 | 5·9 | 5·8 | 6·0 | 5·5 | 10·4 |
| September | 52 | W.S.W. | 5·7 | 5·3 | 7·1 | 4·5 | 5·7 | 4·9 | 10·1 |
| October | 20 | E.N.E. | 7·8 | 8·4 | 6·6 | 6·8 | 7·4 | 3·4 | 9·8 |
| November | 14 | N.N.E. | 4·0 | 4·7 | 4·0 | 1·8 | 3·7 | 7·1 | 9·6 |
| December | 161 | N.N.E. | 3·1 | 5·2 | 5·0 | 3·4 | 4·2 | 4·8 | 8·1 |
| Annual | 9 | S.S.E. | 4·7 | 5·2 | 4·8 | 3·6 | 4·6 | 6·0 | ... |

# APPENDIX XII.

## MEAN Monthly and Annual Meteorological Results at the Madras Observatory in 1921.

| Month. | Barometer. Reduced to 32°. | Barometer. Daily Range. | Dry Bulb Thermometer. Mean. | Dry Bulb Max. | Dry Bulb Min. | Dry Bulb Range. | Wet Bulb. Mean. | Wet Bulb Min. | Tension of Vapour. By Simpson's Tables. | Relative Humidity. By Simpson's Tables. | Sun Max. in Vac. | Min. on Grass. | Wind. Daily Velocity. | Wind. Mean Direction. | Wind. Mean Direction. | Rain. Amount. | Rain. Days | Cloudy sky. | Bright sunshine. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Inches. | ° | ° | ° | | ° | ° | Inches. | Cents. | ° | ° | Miles. | Points | Points. | Inches. | No. | Cents. | Hours. |
| January | 29·964 | 0·108 | 77·4 | 84·4 | 71·6 | 12·8 | 72·5 | 69·8 | 0·734 | 78 | 144·9 | 69·1 | 106 | 3 | N.E. by E. | 5·46 | 8 | 53 | 190·1 |
| February | ·935 | ·124 | 76·7 | 86·3 | 67·4 | 18·9 | 69·7 | 65·9 | ·632 | 68 | 150·3 | 63·7 | 47 | 10 | E.S.E. | . | . | 18 | 262·8 |
| March | ·862 | ·139 | 80·8 | 90·1 | 72·3 | 17·8 | 74·5 | 70·8 | ·767 | 73 | 151·2 | 68·9 | 83 | 14 | S S E. | ... | . | 12 | 277·1 |
| April | ·828 | ·127 | 84·0 | 92·4 | 78·0 | 14·4 | 77·9 | 76·0 | ·871 | 75 | 152·4 | 76·0 | 126 | 15 | S. by E. | 1·99 | 6 | 39 | 246·2 |
| May | ·660 | ·123 | 89·8 | 104·6 | 82·8 | 21·8 | 78·5 | 75·8 | ·821 | 59 | 155·2 | 81·2 | 172 | 17 | S by W. | . | .. | 25 | 213·9 |
| June | ·662 | ·109 | 88·5 | 100·5 | 82·2 | 18·3 | 76·8 | 74·6 | ·762 | 57 | 150·6 | 80·8 | 171 | 19 | S.W. by S. | 0·65 | 5 | 59 | 142·4 |
| July | ·699 | ·112 | 83·9 | 93·2 | 77·9 | 15·3 | 77·4 | 73·9 | ·850 | 75 | 140·8 | 76·3 | 139 | 19 | S.W. by S. | 8·34 | 18 | 75 | 78·8 |
| August | ·741 | ·126 | 83·7 | 93·6 | 77·5 | 16·1 | 77·5 | 74·3 | 856 | 75 | 147·7 | 75·7 | 138 | 17 | S by W. | 7·29 | 14 | 60 | 164·8 |
| September | ·783 | ·129 | 83·3 | 93·1 | 77·0 | 16·1 | 76·5 | 73·5 | ·820 | 72 | 150·1 | 75·0 | 130 | 18 | S S W. | 2·55 | 14 | 57 | 146·8 |
| October | ·862 | ·122 | 79·7 | 85·9 | 74·9 | 11·0 | 76·3 | 73·8 | ·859 | 85 | 139·4 | 73·6 | 111 | 15 | S by E. | 24·27 | 22 | 74 | 106·0 |
| November | ·983 | ·114 | 77·2 | 85·1 | 70·1 | 15·0 | 71·6 | 68·5 | ·699 | 75 | 149·6 | 66·6 | 136 | 31 | N. by W. | 1·84 | 2 | 37 | 212·6 |
| December | ·993 | ·110 | 75·9 | 84·2 | 69·4 | 14·8 | 70·5 | 67·4 | ·672 | 75 | 144·4 | 66·2 | 165 | 2 | N.N.E. | 2·04 | 7 | 54 | 148·0 |
| Annual | 29·831 | 0·120 | 81·7 | 91·1 | 75·1 | 15·2 | 75·0 | 72·0 | 0·779 | 72 | 148·1 | 72·8 | 127 | 15 | S by E. | 54·43 | 96 | 47 | 2189·5 |

## EXTREME Monthly Meteorological Records at the Madras Observatory in 1921.

| Month. | Barometer. Highest. | | Barometer. Lowest. | | Barometer. Range. | Dry Bulb Thermometer. Highest. | | Dry Bulb Thermometer. Lowest. | | Wet Bulb. Lowest. | | Humidity. Lowest. | | Sun Th. in Vacuo. Highest. | | Grass Therm Lowest. | | Wind. Highest. | | Wind. Lowest. | | Rain. Greatest Fall. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inches. | Day. | Inches. | Day. | Inches. | ° | Day. | ° | Day. | ° | Day. | Cents. | Day. | ° | Day. | ° | Day. | Miles. | Day. | Miles. | Day. | Inches. | Day. |
| January | 30·079 | 5 | 29·854 | 21 | 0·225 | 87·6 | 2 | 65·8 | 31 | 64·4 | 31 | 53 | 6 | 154·0 | 6 | 62·1 | 6 | 210 | 9 | **15** | **31** | 3·13 | 12 |
| February | ·075 | 25 | ·834 | 1 | ·241 | 93·7 | 28 | 64·6 | 27 | 62·8 | 18 | 32 | 28 | 154·3 | 10 | 60·5 | 20&27 | 125 | 17 | 21 | 14 | . | . |
| March | ·025 | 6 | ·699 | 3 | ·326 | 94·5 | 2 | 68·2 | 1 & 5 | 66·1 | 5 | 46 | 1 | 155·3 | 5 | 63·5 | 1 | 167 | 8 | 33 | 5 | . | . |
| April | 29·995 | 15 | ·697 | 9 | ·298 | 95·9 | 22&23 | 73·5 | 15 & 16 | 71·3 | 16 | | 5 & 26 | 158·4 | 15& 17 | 72·3 | 5 | 231 | 7 | 53 | 16 | 0·91 | 16 |
| May | ·883 | 1 | **·512** | **13** | **·371** | **111·2** | **25** | 76·2 | 1 | 71·5 | 14& 17 | **21** | **26** | 168·0 | 25 | 73·9 | 1 | 246 | 18 | 107 | 12 | .. | |
| June | ·760 | 4 | ·518 | 18 | ·242 | 106·7 | 1 | 78·2 | 13 | 72·3 | 2 | 28 | 22 | **168·3** | **9** | 76·6 | 13 | 286 | 21 | 92 | 12 | 0·47 | 11 |
| July | ·869 | 19 | ·569 | 6 | ·300 | 102·6 | 2 | 72·4 | 19 | 70·5 | 1 | 38 | 2 | 155·2 | 3 | 71·4 | 20 | 219 | 2 | 68 | 13 | 2·66 | 19 |
| August | ·845 | 4 | ·613 | 23 | ·232 | 98·2 | 23 | 72·6 | 25 | 70·7 | 25 | 40 | 17 | 159·4 | 28 | 73·2 | 3 & 4 | 167 | 10 | 91 | 31 | 1·62 | 1 |
| September | ·906 | 11 | ·615 | 5 | ·291 | 98·7 | 23 | 73·4 | 11 | 70·6 | 11 | 39 | 5 | 165·0 | 24 | 72·0 | 11 | 192 | 4 | 87 | 14 | 0·47 | 1 |
| October | 30·028 | 18 | ·682 | 7 | ·346 | 92 6 | 6 | 72·4 | 8 | 70·7 | 8 | 59 | 16 | 162·1 | 12 | 70·2 | 23 | **290** | **8** | 39 | 14 | **3·28** | **13** |
| November | ·116 | 29 | ·828 | 6 | ·288 | 86·8 | 18 | **63·6** | **10** | **62·5** | **10** | 42 | 9 | 155·5 | 12 | **59·4** | **10** | 235 | 27 | 49 | 2 | 1·19 | 1 |
| December | **·124** | **11** | ·889 | 29&31 | ·235 | 86·3 | 2 | 63·9 | 22 | 63·0 | 22 | 49 | 2 | 154·0 | 21 | 59·5 | 22 | 264 | 27 | 83 | 21 | 0·81 | 29 |